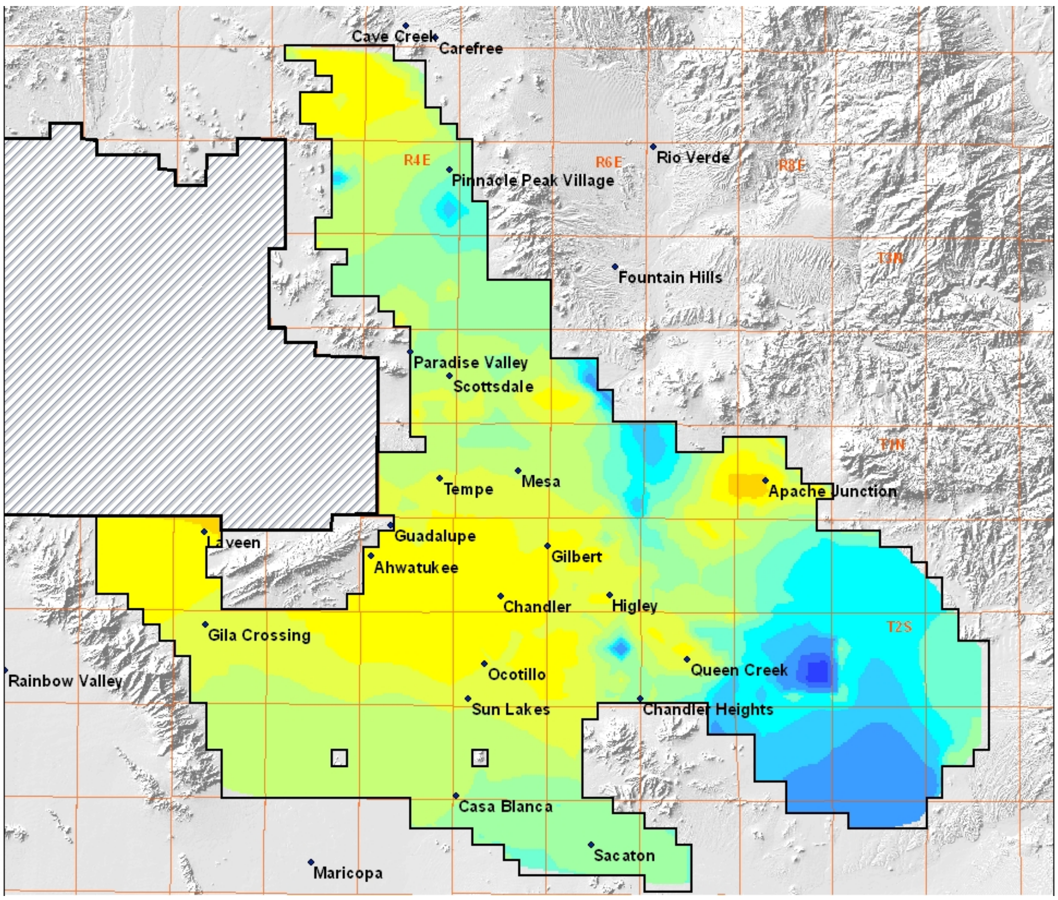
Arizona Department of Water Resources

# East Valley Water Forum Scenarios for the East Salt River Valley Sub-basin an Application of the Regional Groundwater Flow Model of the Salt River Valley, Arizona




**Modeling Report No. 17**

By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# Abstract

The East Valley Water Forum (Forum) was created to develop a water management plan for the East Salt River Valley (ESRV) in the Phoenix Active Management Area (AMA), located in central Arizona. The Forum is a partnership of tribal, public and private water agencies and interested stakeholders involved in water resource management in the ESRV. One of the first stages of developing a plan was to determine what resources currently existed. The U. S. Bureau of Reclamation compiled an inventory of the structural resources that are currently available for treating and moving water. The Forum then looked at the current groundwater resources and projected different water use and supply scenarios into the future. To accomplish this task the Forum chose to use the most current version of The Arizona Department of Water Resources (ADWR) Salt River Valley (SRV) groundwater flow model. The model uses the U.S. Geological Survey's MODFLOW groundwater modeling software to simulate quasi three-dimensional flow in the regional aquifer (Bota and others, 2004). The ADWR groundwater modeling section assisted the Forum in assessing their current plans, determining where problems could exist, possible solutions, and running the Forum's scenarios. The scenarios presented are the East Valley Water Forum's and do not necessarily represent ADWR's official view of future conditions. In addition, these scenarios were completed specifically to provide information for the Forum's water management plan.

The Forum designed three scenarios to run in the SRV model. The first scenario or Base Case Scenario was a "business as usual" scenario. The intent of this scenario was to capture the independent current long-term plans that water providers in the ESRV have concerning groundwater use in the ESRV out to the year 2030. Groundwater use, in this report, refers to all groundwater withdrawals regardless of the water's legal characteristics. This scenario also took into account regional impacts to the aquifer over time such as the urbanization of irrigated land and projected recharge from Underground Storage Facilities (USF). The Department worked closely with the Forum in collecting the data for the Base Case Scenario. As with all the scenarios, the data and assumptions used in the scenario were chosen by the Forum. In general the results demonstrated approximately a 1.5 foot per year decline over much of the area by the year 2030 with the

southeastern portion of the ESRV demonstrating an equivalent rise due to a large proposed USF project in that area. The Base Case Scenario showed groundwater rising near the larger USFs and a cone of depression developing in the Apache Junction area (referred to as the North Meridian Road depression). The Forum decided to run the Base Case scenario out to the year 2100 to capture the effects of long term development on the State Land in the southeastern portion of the ESRV. The results of this scenario showed greater variability in water level decline over the model area, ranging from 1 to 2 feet per year by the year 2100 in the ESRV. Overall, when comparing the results of the 2030 Base Case Scenario to the 2100 Base Case Scenario, the effects of the USFs that were noticed in the 2030 scenario were reduced by the year 2100, and the North Meridian Road depression expanded. A cone of depression also developed in the Queen Creek Wash area that was not present in 2030.

The second scenario was designed to look at a balance in the ESRV between pumping and recharge. The conceptual water budget showed an approximate balance between recharge and pumping for the year 2020. Therefore the Forum decided to keep the recharge and pumping inputs into the model constant from the year 2020 out to the year 2100. As would be expected there was very little difference by the year 2030 when compared to the Base Case Scenario. By the year 2100, the western portion of the ESRV showed the water level decline ranging between 0.5 to 1 foot per year. The southeastern portion of the study area exhibited a rise of 1 to 2.5 feet per year. The North Meridian Road depression expanded only slightly from the years 2030 to 2100 in this scenario.

The third scenario explored ways of possibly reducing the cones of depression that formed in the Base Case Scenario. For Scenario 3A the pumping from the Apache Junction Water Company and Arizona Water Company – Apache Junction was reduced by 70% and moved to the south closer to the large USF. The projected pumping for the Superstition Vistas area was reduced to the amount of recharge at the large USF in the area (56,500 acre-feet per year). Version 3B of this scenario kept the assumptions of Scenario 3A the same except for moving the combined Apache Junction pumping to the north. The last version, Scenario 3C, used the same assumptions as Scenario 3A and reduced the pumping for Superstition Vistas by an additional amount equal to the volume of pumping moved from the Apache Junction area. In the Base Case Scenario by the year 2100, the projected depth to water (dtw) for the North Meridian Road depression was 800 feet below land surface (bls). Scenario 3 reduced the cone of depression by various amounts, Scenario 3A projected dtw of 700 feet bls and Scenarios 3B and 3C projected dtw to 650 feet bls.

The Forum has made great strides in coming together as a group to develop a regional plan for managing the water resources in the ESRV. The value of running scenarios in a regional groundwater flow model is not necessarily in the specific results but in how the various scenarios compare with each other and the overall impact they have on the regional aquifer. The Base Case scenario shows that if the water providers follow their individual plans with no regional collaboration, the ESRV will experience groundwater declines over much of the area. The work the Forum has done on these scenarios set the groundwork for the Forum to develop and refine a water management plan that takes into account the whole of the ESRV, the requirements of ADWR's management plan, and effectively plan for the future.

ADWR was able to supply the tools and means necessary for the ESRV water providers and other stakeholders to create the water demand and supply scenarios the Forum needed to write a regional water plan. This process could not have happened without the commitment, cooperation, and team work that the members of the Forum brought to this project.

# Acknowledgements

The Arizona Department of Water Resources – Hydrology Division – Modeling Section would like to acknowledge those individuals and organizations that have provided information, guidance, and suggestions during the development of this project. Special recognition goes to the members of the East Valley Water Forum with out whose commitment, time, and data this project would not have been possible.

Numerous individual have provided information, suggestions, comments, and assistance during the progress of the modeling portion of this project and the development of the report. Special thanks go to the following: Teresa Makinen for keeping the whole project organized and moving forward; Doug Toy from the City of Chandler for his technical expertise of the East Salt River Valley; Lou Bota from ADWR's modeling section for his assistance in the numerous model runs that were done for this project; Mark Preszler from ADWR's GIS section for his support and partnership in developing and maintaining the modeling interface, Jacqueline Pursell for her invaluable service providing GIS support for this document, numerous members of the Phoenix AMA for their support throughout this project; Frank Putman and Frank Corkhill from ADWR's Hydrology Division for their invaluable assistance in making this a readable document; and Robin Stinnett from the Phoenix AMA for her assistance, support, and expertise throughout the project.

# Introduction

## Background

The East Valley Water Forum (Forum) is a partnership of tribal, public and private water agencies and interested stakeholders involved in water resource management in the East Salt River Valley (ESRV) of Arizona (Figure 1). The Arizona Department of Water Resources (ADWR) through the Phoenix Active Management Area (AMA) provided the initial funding to start the Forum. The mission of the Forum is to develop reliable water supplies through partnerships and a cooperative regional approach to water resource planning and management, including regional recharge and recovery facilities. Their goal is to develop and implement an East Salt River Valley water resource plan that incorporates a regional approach to water quantity and water quality planning.

As part of developing the water resource plan, the Forum worked with ADWR to develop a current groundwater model scenario of the ESRV with alternate scenarios that explore different pumping, recharge, and recovery schemes. The management plan developed by the Forum is separate from the 4$^{th}$ Management Plan being developed by ADWR for the entire Phoenix AMA.

## Purpose and Scope

The purpose of this modeling effort was to simulate groundwater conditions in the ESRV under different stresses and identify areas of concern, as identified by the Forum, using the Department's most recent version of the Salt River Valley (SRV) groundwater flow model. The results of the model scenarios were intended to assist in directing the construction of a regional management plan. This report focuses only on documenting the modeling effort, the assumptions that went into the various scenarios and the results of those scenarios.

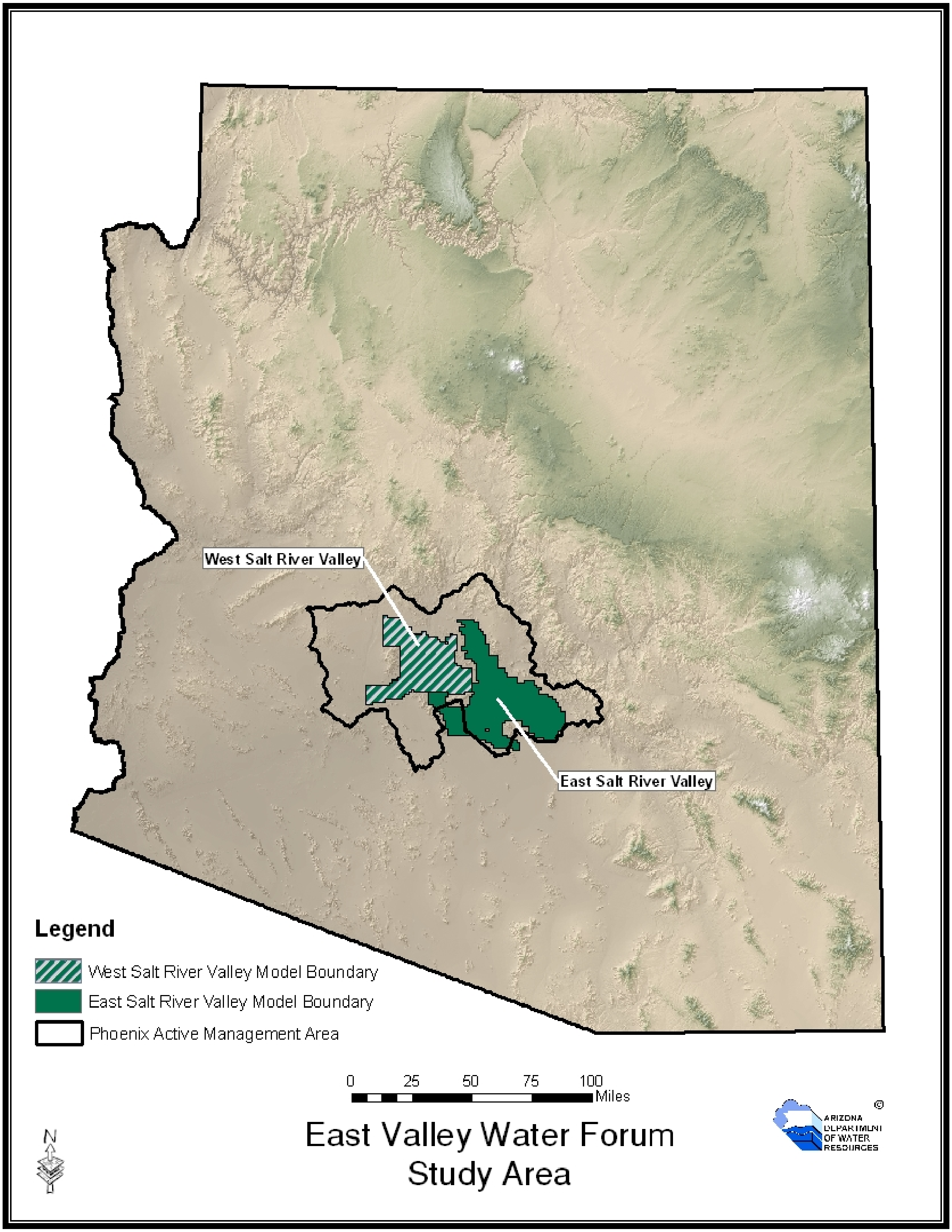


**Figure 1. East Valley Water Forum Study Area.**

# SRV Groundwater Flow Model

## History

ADWR's original SRV groundwater flow model was published in two phases. The first documented the hydrogeologic framework and the basic data (Corkhill and others, 1993). The second phase documented the various aspects of the numerical model (Corell and Corkhill, 1994). Since that time the model has been periodically updated to account for new water level, pumping, or recharge data, to update MODFLOW packages, or to convert to updated versions of MODFLOW. These changes are documented in: Hipke and others, 1996; and Bota and others, 2004.

## Model Development / Boundary Conditions

The Department's SRV model, calibrated from 1983 to 2002 was used as a base for the scenarios developed by the Forum. For a more detailed discussion of the model used please refer to Bota and others, 2004. This report will only focus on the ESRV portion of the SRV model.

Although future development in the Pinal AMA will undoubtedly alter current groundwater underflow patterns in the southern part of the ESRV, the boundary conditions in the model remained constant through all of the scenarios. While this assumption is not entirely satisfactory, it was necessary due to the lack of independent data that projected the water level change along the SRV model's southern boundary. Additionally maintaining constant boundary conditions throughout the projection periods reduced the number of variables that had to be considered when evaluating the impacts of a given scenario. Mountain front recharge and underflow into and out of the ESRV portion of the SRV model is documented in Table 1.

## Model Assumptions

The ESRV was broken into areas of similar water demand and supplies referred to as Water Planning Areas (WPAs). The WPAs followed current or projected municipal boundaries or water provider boundaries where applicable. If those boundaries were not available, geographic boundaries were used (Figure 2).

The municipalities, water providers, and Indian communities that participated in the Forum provided their best estimates of future water supplies and demands for their particular WPA. Future water supply and demand estimates were developed by the Forum for water providers that did not provide input data for scenario development or for areas that currently are not served by a water provider.

The groundwater use took into account the future water demands in the ESRV and how those demands would be met. Groundwater use, in this report, refers to all groundwater withdrawals regardless of the water's legal characteristics. Most water providers in the ESRV provided detailed projections on the amount and distribution of groundwater withdrawal and projected recharge from Underground Storage Facilities (USFs) in five year increments out to the year 2030. The scenarios also attempted to take into account various changes in agriculture, such as current agricultural land going out of production due to urbanization and, in the case of the Gila River Indian Community, an increase in agricultural production. This report will first cover some base assumptions that were used for all of the scenarios before detailing the differences between the three scenarios.

**Table 1. Mountain Front Recharge and Underflow Into and Out of the ESRV**

| Mountain Front Recharge | | Acre-feet/year |
|---|---|---|
| | Superstition Mountains | 10,000 |
| | McDowell Mountains | 1,000 |
| | **Total** | **11,000** |
| Underflow In | | |
| | Gila River near Sacaton | 7,000 |
| | Gila River near Florence | 3,000 |
| | Queen Creek | 2,000 |
| | **Total** | **12,000** |
| Underflow Out | | |
| | Santa Cruz near Maricopa-Stanfield | 24,000 |
| | Gila River near Arlington | 3,000 |
| | **Total** | **27,000** |

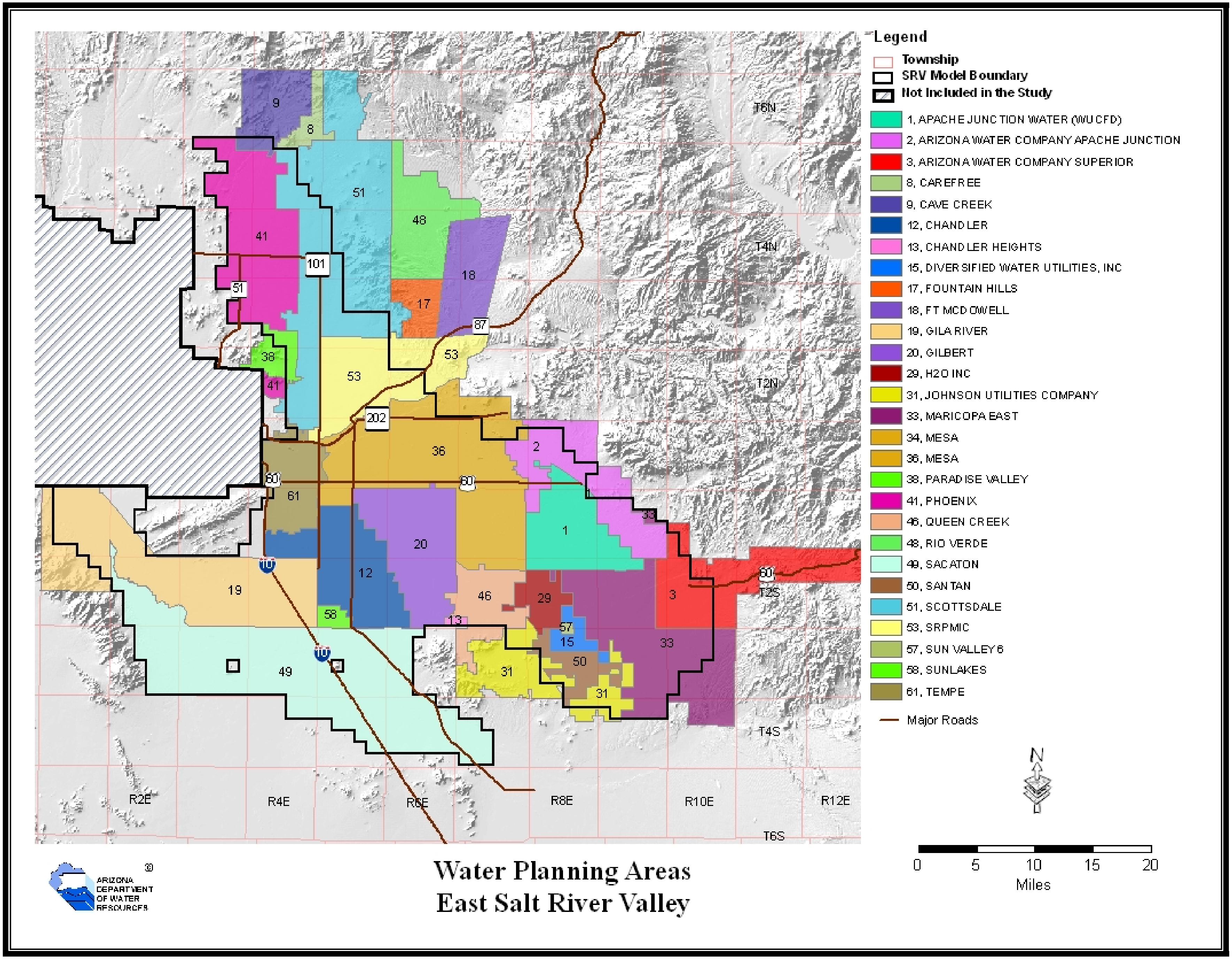


**Figure 2. Water Planning Areas (WPAs) used in the East Salt River Valley.**

## Municipal Pumping

The future municipal pumping in a WPA was determined by one of two methods with one exception. The primary method was to use the information provided by the water providers and municipalities. For the areas that did not provide future pumping plans or for areas that currently are not served by a water provider, the future water demand for a WPA was calculated by using a gallons per housing units (GPHU) value multiplied by a predicted number of housing units. The gallons per housing unit values were obtained from Outlook 2003, a study compiled by the Central Arizona Groundwater Replenishment District (CAGRD) to develop CAP water users' demand projections through the year 2035 (Central Arizona Project, 2004). The number of housing units was determined by using population projections from the Maricopa Association of Governments (MAG), the Central Arizona Association of Governments (CAAG) and the Pinal Association of Governments (PAG). Table 2 shows the GPHU used and the municipal groundwater demand that was provided (or the calculated groundwater demand using the method described above) by WPA for the five-year increments used in the model from 2005 to 2030. The pumping submitted by the City of Chandler represents their safe yield pumping. The City of Chandler's safe yield pumping represents less than half of their projected groundwater demand. The rest of their municipal groundwater demand was represented by recovery pumping (Right Type 74).

The one exception was for the Maricopa East WPA (WPA 33). When the WPAs were first defined, WPA 33 was an area that did not have a municipality or water provider that had developed plans to provide water for this area. A large portion of this WPA is State Land and currently not developed. The Morrison Institute conducted a study looking at the future development of a large tract of State Land located in the ESRV, referred to as Superstition Vistas (Morrison Institute, 2006). As part of the background research for that report, a white paper titled Superstition Vistas: Water Matters was prepared that looked at alternative assured water supply approaches and potential methods of providing water services for Superstition Vistas (Gammage and others, 2005). Although the Superstition Vistas study area is not the same as the Maricopa East WPA, for the purposes of this model, the Forum made the assumption that the groundwater for the Superstition Vistas

## Table 2. Projected Municipal Groundwater Demand per WPA
(acre-feet per year)

| WPA | WPA Name | GPHU[1] | Demand Provided[2] | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | APACHE JUNCTION WATER (WUCFD) | 243 | yes | 1,580 | 1,950 | 2,500 | 3,650 | 5,100 | 7,500 |
| 2 | AZ WATER COMPANY APACHE JUNCTION | 238 | yes | 6,810 | 7,873 | 9,443 | 10,370 | 11,788 | 13,133 |
| 3 | AZ WATER COMPANY SUPERIOR | 341 | yes | 600 | 925 | 1,250 | 1,575 | 1,900 | 2,225 |
| 8 | CAREFREE | 1017 | no | 1,924 | 2,274 | 2,527 | 2,781 | 2,785 | 2,834 |
| 9 | CAVE CREEK | 283 | no | 520 | 593 | 628 | 662 | 1077 | 1399 |
| 12 | CHANDLER | 670 | yes | 4,200 | 5,100 | 5,700 | 6,000 | 6,300 | 6,300 |
| 13 | CHANDLER HEIGHTS | 389 | yes | 3,612 | 4,068 | 4,931 | 5,573 | 5,573 | 5,573 |
| 15 | DIVERSIFIED WATER UTILITIES, INC | 357 | no | 918 | 1,785 | 2,948 | 4,111 | 4,227 | 4,344 |
| 17 | FOUNTAIN HILLS | 483 | no | 4,224 | 4,765 | 5,504 | 6,244 | 6,250 | 6,329 |
| 18 | FT MCDOWELL | 398 | no | 1,117 | 1,224 | 1,327 | 1,431 | 1,500 | 1,571 |
| 19 | GILA RIVER | 243 | no | 193 | 210 | 247 | 284 | 323 | 363 |
| 20 | GILBERT | 761 | yes | 7,556 | 8,300 | 12,336 | 15,800 | 17,500 | 17,500 |
| 29 | H2O INC | 519 | no | 1,516 | 2,883 | 5,105 | 7,326 | 8,112 | 8,882 |
| 31 | JOHNSON UTILITIES COMPANY | 386 | no | 3,429 | 6,462 | 10,613 | 14,763 | 15,339 | 15,915 |
| 33 | MARICOPA EAST[3] | 243 | yes | 855 | 7,000 | 21,500 | 36,000 | 53,000 | 70,000 |
| 36 | MESA | 470 | yes | 10,217 | 10,217 | 10,217 | 18,019 | 25,137 | 25,137 |
| 38 | PARADISE VALLEY | 841 | no | 5,160 | 5,357 | 5,453 | 5,548 | 5,567 | 5,608 |
| 41 | PHOENIX | 632 | yes | 22,536 | 22,540 | 22,541 | 22,541 | 22,541 | 22,542 |
| 46 | QUEEN CREEK | 893 | yes | 6,476 | 13,710 | 13,710 | 13,710 | 13,710 | 13,710 |
| 48 | RIO VERDE | 398 | no | 530 | 643 | 911 | 1,180 | 1,391 | 1,553 |
| 49 | SACATON | 243 | no | 345 | 358 | 372 | 386 | 412 | 438 |
| 50 | SANTAN | 243 | no | 1,110 | 2,157 | 3,560 | 4,964 | 5,101 | 5,238 |
| 51 | SCOTTSDALE | 757 | yes | 27,142 | 21,797 | 24,991 | 26,927 | 27,017 | 27,137 |
| 53 | SRPMIC | 410 | yes | 19,560 | 22,820 | 26,080 | 29,340 | 32,600 | 32,600 |
| 57 | SUN VALLEY | 243 | no | 74 | 143 | 236 | 328 | 336 | 344 |
| 58 | SUN LAKES | 236 | no | 1,747 | 1,824 | 1,851 | 1,879 | 1,890 | 1,907 |
| 61 | TEMPE | 764 | yes | 5,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |

1. Gallons per housing unit from Outlook 2003 (CAGRD, 2003).
2. The demand was either provided or the Forum provided an estimate. If a demand was not provided to ADWR, the GPHU was used to calculate demand.
3. Demand based on the Morrison Institute study (Gammage and others, 2005) and increased to 80,000 af/year from 2040 to 2100.

area would be supplied from the Maricopa East WPA. The Forum also chose to use the groundwater dependent approach for their scenarios. In that scenario the total groundwater portion of the demand, at buildout by the year 2040, was determined to be 80,000 acre-feet/year (af/year) (Gammage and others, 2005). Table 2 shows the increase in municipal demand for the Maricopa East WPA through 2030. The demand for the year 2030 was increased by 10,000 af/year to 80,000 af/year for the years from 2040 and 2100. For lack of other information, the demand was distributed in the area of the large proposed Underground Storage Facility (USF) recharge project (Superstition Mountain USF) that is located in the Maricopa East WPA, where future groundwater recovery is likely.

If a pumping distribution was provided (i.e. well locations) this information was used to distribute the groundwater demand. If a distribution was not provided, then the municipal distribution (well type 56) for the year 2000, as indicated in ADWR records, was used as a base or starting point to determine the future distribution of municipal pumping. Table 3 lists the method of distribution used for future municipal pumping by WPA.

## Agricultural / Irrigation District Pumping

As the ESRV develops, it is predictable that the agricultural and the irrigation district pumping will not continue as the agricultural lands are urbanized. The following process was developed to account for the change in agricultural and irrigation district pumping due to urbanization over the projection period between 2005 and 2030. ADWR records agricultural pumping under two right types, grandfathered rights (Right Type 58) and irrigation district pumping (Right Type 57). The grandfathered rights (GFRs) are split into three categories: 1) irrigation grandfathered rights, 2) Type I non-irrigation grandfathered rights, and 3) Type II non-irrigation grandfathered rights. The reported volumes and distributions from ADWR’s Registry of Grandfathered Rights (RoGR) database for Right Type 58 and Right Type 57 for the year 2000 were used as a base for agricultural pumping. For any model cell that urbanized in a five-year period, the agricultural and irrigation district pumping was removed from that period forward.

## Table 3. Distribution Method for Municipal pumping by WPA

| WPA | WPA Name | Municipal Pumping Distribution Method |
|---|---|---|
| 1 | APACHE JUNCTION WATER (WUCFD) | Specified Locations |
| 2 | AZ WATER COMPANY APACHE JUNCTION | Specified Locations |
| 3 | AZ WATER COMPANY SUPERIOR | Specified Locations |
| 8 | CAREFREE | Proportional to Base Pumping |
| 9 | CAVE CREEK | Proportional to Base Pumping |
| 12 | CHANDLER | Base Distribution used until set limit, then excess spread equally over WPA |
| 13 | CHANDLER HEIGHTS | Specified Locations |
| 15 | DIVERSIFIED WATER UTILITIES, INC | Base Distribution used until set limit, then excess spread equally over WPA |
| 17 | FOUNTAIN HILLS | Proportional to Base Pumping |
| 18 | FT MCDOWELL | Proportional to Base Pumping |
| 19 | GILA RIVER | Distributed evenly over entire WPA |
| 20 | GILBERT | Specified Locations |
| 29 | H2O INC | Base Distribution used until set limit, then excess spread equally over WPA |
| 31 | JOHNSON UTILITIES COMPANY | Distributed evenly over entire WPA |
| 33 | MARICOPA EAST | Specified Locations |
| 36 | MESA | Specified Locations |
| 38 | PARADISE VALLEY | Base Distribution used until set limit, then excess spread equally over WPA |
| 41 | PHOENIX | Specified Locations |
| 46 | QUEEN CREEK | Specified Locations |
| 48 | RIO VERDE | Proportional to Base Pumping |
| 49 | SACATON | Distributed evenly over entire WPA |
| 50 | SANTAN | Distributed evenly over entire WPA |
| 51 | SCOTTSDALE | Specified Locations |
| 53 | SRPMIC | Distributed evenly over entire WPA |
| 57 | SUN VALLEY | Distributed evenly over entire WPA |
| 58 | SUN LAKES | Base Distribution used until set limit, then excess spread equally over WPA |
| 61 | TEMPE | Base Distribution used until set limit, then excess spread equally over WPA |

A model cell was considered to urbanize if at least 50% of a model cell (1 square mile) hadone housing unit per acre. The MAG, CAAG, and PAG population projections were used to determine when a model cell urbanized.

The following grandfathered right wells and irrigation district wells were exceptions to being removed when the model cell urbanized:

Grandfathered Right Wells: Type I and Type II (non-irrigation GFRs)

Irrigation District Wells: Salt River Project (SRP)
Roosevelt Water Conservation District (RWCD)

The assumption for these wells is that if the land around the well urbanized, the well would still be pumped for other purposes. SRP provided volumes and locations of pumping they believed was representative for the five-year increments between 2005 and 2030. The volumes that SRP provided included the projected water that SRP would provide to municipalities. When the municipalities provided their projected groundwater demand, the water projected to be pumped by SRP was not included. The only exception was the City of Chandler because the SRP pumping was included in the demand they provided. SRP did not include the projected pumping that would be supplied to the City of Chandler. For RWCD, the Forum choose to reduce the pumping over time. Table 4 shows the pumping volumes used for SRP and RWCD in the ESRV.

**Table 4. Projected Pumping**
**Volumes for SRP and RWCD for the ESRV**
(acre-feet/year)

| Irrigation District | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| SRP | 82,768 | 85,592 | 88,420 | 90,842 | 90,842 | 90,842 |
| RWCD | 10,000 | 10,000 | 10,000 | 8,000 | 8,000 | 8,000 |

Table 5 is a breakdown of the agricultural (ADWR Right Type 58) and irrigation district pumping (ADWR Right Type 57) for the projection period for the ESRV. Even though Type I and Type II non-irrigation GFR water rights are a subset of Right Type 58, the water is not used for agricultural.

Therefore the water pumped under Type I and Type II GFR water rights was included as part of industrial pumping and not as part of the agricultural water use.

**Table 5. Projected Agriculture and Irrigation District Pumping Volumes for the ESRV**
(acre-feet/year)

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Irrigation District | 104,161 | 105,470 | 107,046 | 106,350 | 104,257 | 104,257 |
| Agricultural | 19,750 | 18,827 | 13,809 | 13,094 | 10,971 | 7,406 |

## Indian Pumping

Two Indian communities are included within the boundaries of ADWR's SRV model: the Salt River Pima-Maricopa Indian Community (SRPMIC) and the Gila River Indian Community (GRIC). For these communities, the Forum developed projected groundwater demands for these areas based on their respective Indian water rights settlements.

In the absence of other information the projected groundwater demand for the SRPMIC was provided by the Forum to simulate projected municipal demand from development along the western boundary of the community.

The Forum projected the groundwater demand for the GRIC to take into account the projected increase in agricultural production as a result of the Indian Rights Settlement. The Gila River WPA (WPA 19) and portions of the Sacaton WPA (WPA 49) make up the portion of the Gila River Indian Reservation that is within the SRV Model boundary. The pumping volumes listed in Table 6 split the total pumping for the GRIC into the projected pumping for the San Carlos Project (irrigated agriculture) and the rest of the GRIC pumping.

**Table 6. Projected SRPMIC and GRIC Pumping Volumes for the ESRV**
(acre-feet/year)

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| SRPMIC | 19,560 | 22,820 | 26,080 | 29,340 | 32,600 | 32,600 |
| GRIC | 86,723 | 106,426 | 125,881 | 145,491 | 145,491 | 145,491 |
| San Carlos Project | 29,328 | 36,778 | 44,133 | 51,547 | 51,547 | 51,547 |

## Other Pumping

Other types of pumping that are included in the projections include small domestic (pumping from exempt wells), industrial (Right Type 59), recovery (Right Type 74), Type I, and Type II. Type I pumping is a grandfathered water right that is tied to the land and is used for a variety of non-irrigation uses. Type II pumping is a grandfathered right, that is usually associated with industrial uses, such as power plants, mineral extraction or other non-irrigation purposes. For the domestic pumping, the volume and distribution that was calculated for the SRV model update (Bota and others, 2004) was held constant for the projections. The reported volumes and distribution for industrial wells and recovery wells for the base year (2000) were held constant for the projection period. The only exception was for the recovery wells in the Chandler WPA (WPA12). The City of Chandler separated their future demands into recovery and groundwater pumping.

**Table 7. Projected Domestic, Industrial and Recovery Pumping Volumes for the ESRV**
(acre-feet/year)

| | Right Type | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| Domestic | -- | 2,911 | 2,911 | 2,911 | 2,911 | 2,911 | 2,911 |
| Industrial | 59 | 2,844 | 2,844 | 2,844 | 2,844 | 2,844 | 2,844 |
| Type I | 58 | 4,898 | 4,898 | 4,898 | 4,898 | 4,898 | 4,898 |
| Type II | 58 | 23,762 | 23,762 | 23,762 | 23,762 | 23,762 | 23,762 |
| Recovery - Chandler | 74 | 13,817 | 12,900 | 16,300 | 16,000 | 15,700 | 15,700 |
| Recovery – all other | 74 | 4,017 | 4,017 | 4,017 | 4,017 | 4,017 | 4,017 |

## Agricultural Recharge

Agricultural recharge is an important part of the replenishment of the aquifer in the Salt River Valley. Agricultural recharge is basically determined by calculating the amount of water that is applied to the field, used by the plants, lost as runoff from the field, or evaporated. The remaining volume is the amount of water that is available for recharge. Due to the limited data available and the accuracy of the data, various methods were used to calculate the potential agricultural recharge over different time periods.

The potential agricultural recharge calculation for the period from 1968 to 1981 started with the 1973 agricultural distribution map from the USGS (USGS and others, 1973).

This was used to determine the amount and distribution of the irrigated land. Then the amount of agricultural pumping was determined by using a ratio of agricultural versus non-agricultural pumping. The amount of agricultural pumping was combined with the total surface water available and rainfall to determine the amount of water that was applied to the irrigated land. The potential agricultural recharge was calculated by multiplying the total water applied to the irrigated land by an overall regional soil efficiency of 60%. This means that of the amount of water that was applied to the irrigated land 40% of the water was recharged. The amount and distribution of potential agricultural recharge that was calculated was used as a representative value for the time period from 1968 to 1981.

The potential agricultural recharge for the period between 1982 to 2002 was estimated on an annual basis. The calculation used the process described in Modeling Report 6 (Corkhill and others, 1993). The Arizona Agricultural Statistics provided the total major crop acreage for Maricopa County on an annual basis. The total crop acreage was multiplied by 82% to account for the acreage which was inside the county, but outside the SRV model area. The agricultural water use was estimated by taking into account the total cropped acreage, the appropriate consumptive use factors, and an average irrigation efficiency. The potential agricultural recharge was then determined by multiplying the agricultural water use by an irrigation efficiency.

The 2003 potential agricultural recharge was estimated using information on cropped acreage and crop type developed by ADWR from Landsat image analysis. These data were combined with crop-consumptive use, effective precipitation and irrigation efficiency data to develop estimates of total cropped acreage, total irrigation requirement, total water duty and total potential agricultural recharge for the AMA. The amount and distribution of potential agricultural recharge in the year 2003 was used as a base for the projected time period from 2005 to 2030, with an exception that is described in more detail below. When a model cell was urbanized, the amount of water available for recharge was removed from the base. The urbanization method used is the same as discussed under the Agricultural / Irrigation District Pumping section.

The Gila River WPA (WPA 33) and Sacaton WPA (WPA 49) were exceptions to using the 2003 potential agricultural recharge as a base for the 2005 to 2030 time period. The amount available for potential agricultural recharge was increased to account for the projected increase in irrigated agricultural land in both of these WPAs. The Gila River Indian Community plans to increase the amount of irrigated land to 146,330 acres within 15 years (EcoPlan, 1997). Starting in 2005 the amount of irrigated land was increased by almost 43,000 acres every five years until 2020 and then it was held constant. For the areas that were irrigated in 2003, the amount and distribution of potential agricultural recharge was kept constant for the projection period. The new irrigated acres were assumed to be more efficient (80%) due to applying modern techniques such as laser leveling. The distribution of this recharge was spread equally over model cells that were not already being irrigated but were located in an area of potential agricultural land as determined in a Programmatic Environmental Impact Statement (EcoPlan, 1997).

Once the volume of potential agricultural recharge was determined, the volume of water was then "lagged" to account for the travel time from the land surface to the aquifer. A standard travel time of twenty feet per year was used throughout the SRV model. The amount of lag time is a rough estimation. In part, the lag time was determined based on work that showed the soil moisture traveling over eight feet in thirty days (Marr, 1927). An independent review of the Department's groundwater flow model for the Pinal AMA suggested a lag time of twelve to twenty feet per year (Burgess and Niple, 2004). The amount of agricultural recharge that was applied to the aquifer was determined by using the calculated potential agricultural recharge and the 2003 depth to water (dtw) as a base for determining when the potential agricultural recharge would actually reach the aquifer. The total amount of projected agricultural recharge for the ESRV per five-year increment for the period from 2005 to 2030 is documented in Table 9.

## Underground Storage Facility (USF) Recharge

At the time of this study, there were nineteen permitted USFs in the ESRV. Two potential USFs were included; a Central Arizona Project (CAP) project referred to as Superstition Mountain, and a City of Mesa project, referred to as the East Maricopa Floodway.

Table 8 lists the various USFs by WPA and the amount of recharge for the projection period. The municipality or organization that operates the USF supplied most of the volume data for the USFs.

For the Superstition Mountain USF, the proposed maximum permitted volume of yearly recharge was used in the model. The North Gateway USF was not included in the scenarios because it is located outside the model boundary. SRP's Granite Reef Underground Storage Project (GRUSP) project is permitted for 250,000 acre-feet per year. However, 80,000 acre-feet per year was used as a reasonable long-term projected estimate for that USF. Although the GRUSP USF is located outside of the SRV model boundary, due to the size of the USF, it was decided to include it in the model. The nearest active model cell was two miles to the west of the actual location of the GRUSP USF. Due to constraints of the model, only 40,000 acre-feet per year was used in the scenarios. Even with the reduced amount of recharge at the GRUSP USF, the water level reached land surface during the projections. Figure 3 shows the locations of the model cells that were used to represent the various USFs. The Superstition Mountain USF was split between four model cells due to constraints of the modeling program. Table 9 lists the total amount of projected USF recharge used in the model for the ESRV.

**<u>Other Types of Recharge</u>**

Incidental recharge includes the projected recharge estimated for turf facilities greater than 10 acres, seepage from lakes, recharge from residential areas with flood irrigation (urban), leakage from irrigation district canals, leakage from canals on the San Carlos Irrigation Project (SCIP), and annualized floods for the Salt and Gila Rivers. The Salt and Gila Rivers do not flood every year, however, historically when floods occur, significant amounts of recharge to the aquifer takes place. Instead of attempting to estimate the probable times when flood events would occur in the future, the historical amount of recharge was averaged out over an annual period. This amount was held constant throughout the projection period. For a more detailed accounting of how the incidental recharge was determined, please refer to Hipke and others, 1996; and Bota and others, 2004. A complete listing of the projected incidental recharge volumes, for the ESRV, that were used in the Forum's scenarios is listed in Table 9.

**Table 8. Projected Recharge Volumes for Individual USFs for the ESRV by WPA**
(acre-feet/year)

| USF Projects | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| **Chandler – WPA 12** | | | | | | |
| Intel | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Ocotillo | 200 | 200 | 200 | 200 | 200 | 200 |
| Ocotillo ASR | 0 | 0 | 1,000 | 0 | 1,000 | 2,000 |
| Tumbleweed Park | 4,500 | 0 | 5,200 | 0 | 3,900 | 4,900 |
| Chandler Heights | 0 | 0 | 500 | 0 | 500 | 0 |
| **Gilbert – WPA 20** | | | | | | |
| Neely Wildlife Habitat | 2,500 | 3,248 | 3,248 | 3,248 | 3,248 | 3,248 |
| Riparian Preserve | 4,368 | 4,368 | 4,368 | 4,368 | 4,368 | 4,368 |
| Municipal ASR | 1,000 | 2,200 | 2,200 | 2,200 | 2,200 | 2,200 |
| Gilbert South | 0 | 10,081 | 10,081 | 10,081 | 10,081 | 10,081 |
| **Maricopa East – WPA 33** | | | | | | |
| Superstition Mts. | 56,500 | 56,500 | 56,500 | 56,500 | 56,500 | 56,500 |
| **Mesa - WPA 36** | | | | | | |
| NWWR | 1,531 | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 |
| Red Mountain | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| E. Maricopa Floodway | 0 | 1,700 | 3,500 | 4,500 | 1,500 | 1,500 |
| **Phoenix – WPA 41** | | | | | | |
| Cave Creek | 6,000 | 8,961 | 8,961 | 8,961 | 8,961 | 8,961 |
| **Phoenix – WPA 42** | | | | | | |
| N. Gateway | 1,742 | 1,742 | 1,742 | 1,742 | 1,742 | 1,742 |
| **Scottsdale – WPA 51** | | | | | | |
| Water Campus | 6,597 | 20,946 | 16,042 | 19,165 | 23,783 | 23,783 |
| **SRPMIC – WPA 53** | | | | | | |
| GRUSP | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| **Sun Lakes – WPA 58** | | | | | | |
| Sun Lakes | 628 | 628 | 628 | 628 | 628 | 628 |
| **Tempe –WPA 61** | | | | | | |
| Kyrene | 500 | 1,500 | 2,000 | 2,000 | 2,000 | 2,000 |
| **Total** | **168,066** | **195,574** | **199,670** | **197,093** | **204,111** | **205,611** |

**Table 9. Projected Incidental Recharge Volumes for the ESRV**
(acre-feet/year)

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Turf | 10,947 | 10,947 | 10,947 | 10,947 | 10,947 | 10,947 |
| Lakes | 8,274 | 8,274 | 8,274 | 8,274 | 8,274 | 8,274 |
| Urban | 10,047 | 10,047 | 10,047 | 10,047 | 10,047 | 10,047 |
| Canals | 23,082 | 23,082 | 23,082 | 23,082 | 23,082 | 23,082 |
| SCIP* | 39,634 | 39,634 | 39,634 | 39,634 | 39,634 | 39,634 |
| Salt River | 44,667 | 44,667 | 44,667 | 44,667 | 44,667 | 44,667 |
| Gila River | 37,155 | 37,155 | 37,155 | 37,155 | 37,155 | 37,155 |
| **Total** | **173,806** | **173,806** | **173,806** | **173,806** | **173,806** | **173,806** |

* San Carlos Irrigation Project

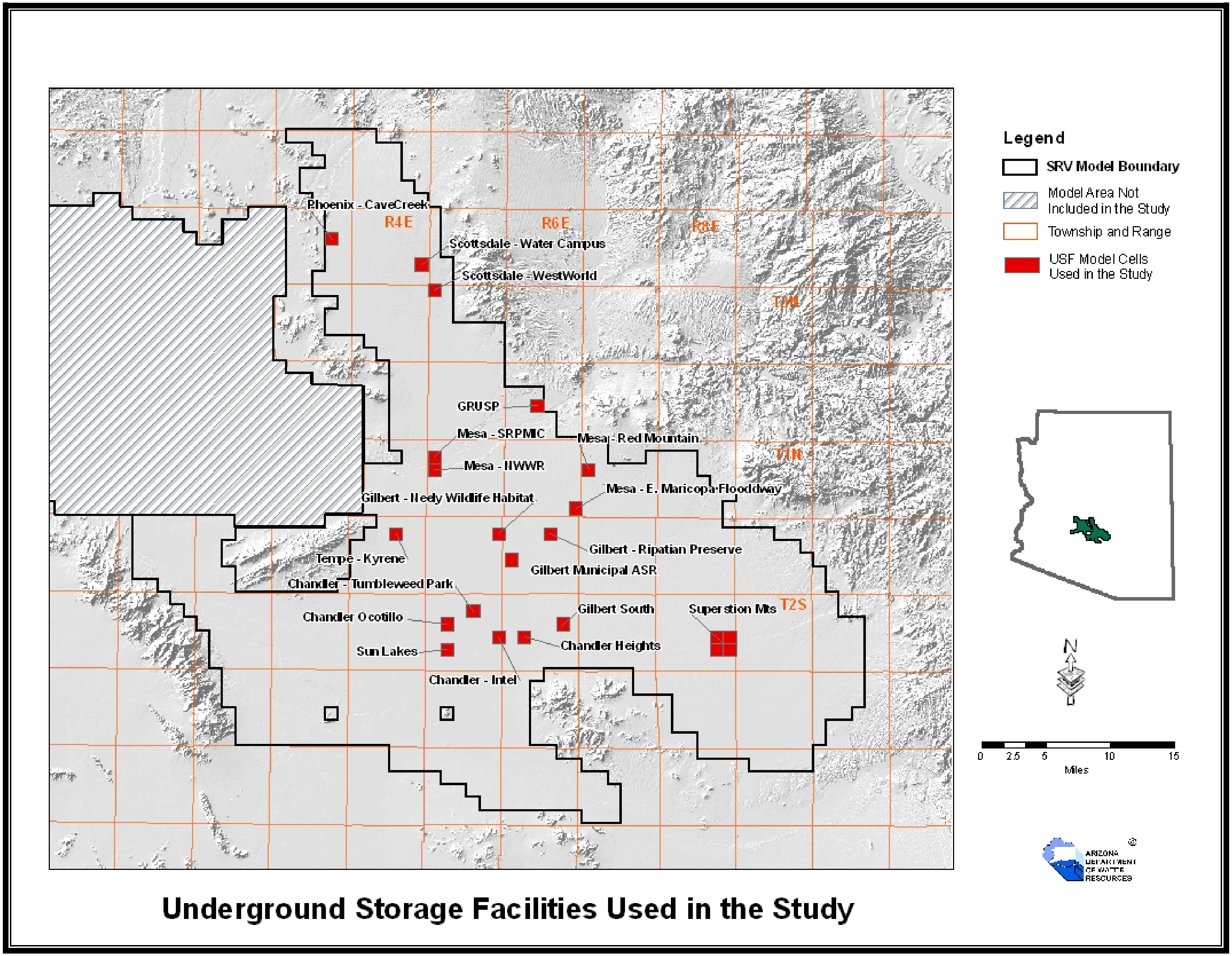


**Figure 3. Underground Storage Facilities (USFs) used in the EVWF scenarios.**

## Summary

The pumping and recharge volumes that have been discussed so far are projections for the entire ESRV. A summary of these projected volumes for recharge and pumping are included in Tables 10 and 11, respectively.

**Table 10. Projected Recharge Volumes for the ESRV**
(acre-feet/year)

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Agricultural | 221,200 | 208,738 | 200,761 | 260,148 | 253,922 | 215,507 |
| USF | 168,066 | 195,574 | 199,670 | 197,093 | 204,111 | 205,611 |
| Turf | 10,947 | 10,947 | 10,947 | 10,947 | 10,947 | 10,947 |
| Lakes | 8,274 | 8,274 | 8,274 | 8,274 | 8,274 | 8,274 |
| Urban | 10,047 | 10,047 | 10,047 | 10,047 | 10,047 | 10,047 |
| Canals | 23,082 | 23,082 | 23,082 | 23,082 | 23,082 | 23,082 |
| SCIP* | 39,634 | 39,634 | 39,634 | 39,634 | 39,634 | 39,634 |
| Salt River | 44,667 | 44,667 | 44,667 | 44,667 | 44,667 | 44,667 |
| Gila River | 37,155 | 37,155 | 37,155 | 37,155 | 37,155 | 37,155 |
| **Total** | **563,072** | **578,118** | **574,237** | **631,047** | **631,839** | **594,924** |

* San Carlos Irrigation Project

**Table 11. Projected Pumping for the ESRV**
(acre-feet/year)

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Municipal | 139,695 | 164,013 | 202,100 | 246,092 | 279,477 | 303,082 |
| Irrigation District | 104,161 | 105,470 | 107,046 | 106,350 | 104,257 | 104,257 |
| Agriculture | 48,410 | 47,487 | 42,469 | 41,754 | 39,631 | 36,066 |
| GRIC* | 86,723 | 106,426 | 125,881 | 145,491 | 145,491 | 145,491 |
| GRIC*-San Carlos Project | 29,328 | 36,778 | 44,133 | 51,547 | 51,547 | 51,547 |
| Domestic | 2,911 | 2,911 | 2,911 | 2,911 | 2,911 | 2,911 |
| Industrial | 2,844 | 2,844 | 2,844 | 2,844 | 2,844 | 2,844 |
| Recovery | 13,817 | 16,917 | 20,317 | 20,017 | 19,717 | 19,717 |
| **Total** | **427,889** | **482,846** | **547,701** | **617,006** | **645,875** | **665,915** |

* Gila River Indian Community

Table 12 shows the projected difference between recharge and pumping for the projection periods. Through 2020, there is more projected recharge going into the ESRV than there is projected pumping. By 2030 the projected demand for the Superstition Vistas has a major impact on the difference between recharge and pumping. Even though most of the projected pumpage and recharge estimates were held constant after the year 2030, the year 2040 is listed here to show the addition of 10,000 acre-feet per year of pumping for the Superstition Vistas are.

**Table 12. Projected Total Recharge vs. Pumping Volumes for the ESRV**
(acre-feet/year)

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2040 |
|---|---|---|---|---|---|---|---|
| Recharge | 563,072 | 578,118 | 574,237 | 631,047 | 631,839 | 594,924 | 594,924 |
| | | | | | | | |
| Pumping | 427,889 | 482,846 | 547,701 | 617,006 | 645,875 | 665,915 | 675,915 |
| **Difference** | **135,183** | **95,272** | **26,536** | **14,041** | **-14,036** | **-70,991** | **-80,991** |

Some of the WPAs are partially or completely outside of the SRV model boundary. Any recharge or pumping that was assigned to these areas was not included in the model. Tables 13 and 14 show the recharge and pumping volumes, broken down into their individual components, that were used in the SRV model for the EVWF's Base Case Scenario.

Table 15 shows the difference between the recharge and pumping volumes for the projection period that occurred inside the SRV model boundary. The values for 2040 were held constant out to the year 2100 for the Base Case Scenario. The volumes that the SRV model actually simulated are slightly less than those represented here due to model cells going dry. From the water budget obtained from MODFLOW, the recharge actually simulated in the SRV model was approximately 3 percent less than the total recharge volume in Table 13. The pumping simulated in the SRV model was approximately 0.7 percent less than the volume in Table 14. There was little change in the pumping volume used, primarily because when a model cell went dry the associated pumping was manually moved to a deeper cell, if possible.

**Table 13. Projected Recharge Volumes within the ESRV Model Boundary**
(acre-feet/year)

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Agricultural | 207,227 | 199,390 | 192,864 | 252,007 | 246,170 | 207,756 |
| USF | 69,824 | 153,832 | 157,928 | 155,351 | 162,369 | 163,869 |
| Turf | 10,913 | 10,913 | 10,913 | 10,913 | 10,913 | 10,913 |
| Lakes | 8,274 | 8,274 | 8,274 | 8,274 | 8,274 | 8,274 |
| Urban | 9,965 | 9,965 | 9,965 | 9,965 | 9,965 | 9,965 |
| Canals | 22,929 | 22,929 | 22,929 | 22,929 | 22,929 | 22,929 |
| SCIP* | 38,731 | 38,731 | 38,731 | 38,731 | 38,731 | 38,731 |
| Salt River | 44,667 | 44,667 | 44,667 | 44,667 | 44,667 | 44,667 |
| Gila River | 37,155 | 37,155 | 37,155 | 37,155 | 37,155 | 37,155 |
| **Total** | **449,685** | **525,856** | **523,426** | **579,992** | **581,173** | **544,259** |

* San Carlos Irrigation Project

**Table 14. Projected Pumping Volumes within the ESRV Model Boundary**
(acre-feet/year)

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|
| Municipal | 124,233 | 144,893 | 178,177 | 217,384 | 249,643 | 272,097 |
| Irrigation District | 104,161 | 105,470 | 107,046 | 106,350 | 104,257 | 104,257 |
| Agriculture | 48,187 | 47,264 | 42,264 | 41,531 | 39,408 | 35,843 |
| GRIC* | 86,723 | 106,426 | 125,881 | 145,491 | 145,491 | 145,491 |
| San Carlos Project | 29,328 | 36,778 | 44,133 | 51,547 | 51,547 | 51,547 |
| Domestic | 2,712 | 2,712 | 2,712 | 2,712 | 2,712 | 2,712 |
| Industrial | 2,836 | 2,836 | 2,836 | 2,836 | 2,836 | 2,836 |
| Recovery | 13,817 | 16,917 | 20,317 | 20,017 | 19,717 | 19,717 |
| **Total** | **411,997** | **463,296** | **523,366** | **587,868** | **615,611** | **634,500** |

* Gila River Indian Community

**Table 15. Projected Total Recharge vs. Pumping Volumes for the ESRV used in the Base Case Scenario**
(acre-feet/year)

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2040 |
|---|---|---|---|---|---|---|---|
| Recharge | 449,685 | 525,856 | 523,426 | 579,992 | 581,173 | 544,259 | 544,259 |
| | | | | | | | |
| Pumping | 411,997 | 463,296 | 523,366 | 587,868 | 615,611 | 634,500 | 644,500 |
| **Difference** | **37,688** | **62,560** | **60** | **-7,876** | **-34,438** | **-90,241** | **-100,241** |

# EVWF Water Management Scenarios

## Introduction

Before creating a water management plan, the Forum wanted to look at the current groundwater resources and the members' current individual plans for meeting water demand into the future. Their individual plans were brought together, along with agreed upon general assumptions of various stresses on the groundwater in the ESRV. The original planning period projected the pumping and recharge out to the year 2030, as discussed in the previous portion of this report. The rest of this report documents the different scenarios and the results of that work. The first model run took the gathered information out to 2030. After the Forum studied the results of that model run and after receiving new information concerning the development of State Lands in the ESRV (Superstition Vistas) the Forum decided to extend the scenario out to the year 2100. This was accomplished by holding the 2030 inputs into the model constant for the next 70 years. This is implying that the amount of urbanization, pumping, and recharge predicted for the year 2030 would not change for the next 70 years.

Holding these major components static for 70 years could be unrealistic. However, when developing model scenarios and analyzing the results, it is important to remember the question: "What are the questions that you are attempting to find answers for?" The Forum wanted to determine where there could be potential problems, what management solutions seemed to work, and what did not seem to work. By running the scenarios out to the year 2100, the model allowed the Forum to account for a potentially large amount of demand in the ESRV and the potential problems were accentuated. For planning purposes, especially going out 100 years, the specific results of a model scenario are not as important as how the results compare to other scenarios/assumptions.

The first scenario was termed the Base Case and was considered a "business as usual" scenario. This scenario simulated the individual management plans being carried out into the future. The Base Case projections provided the Forum with a simulation of what the aquifer conditions might be in the future without regional coordination. After studying the results of the Base Case Scenario, the Forum decided to look at a scenario that demonstrated less of a gap between the amount of pumping compared with the amount of recharge in the ESRV. The last scenario was actually three different scenarios which looked at possible alternatives to reducing the long-term water level decline that were shown to be significant in the previous scenarios.

The amount of pumpage and recharge that the model actually simulated differed slightly from the projected volumes that were gathered for the ESRV. The difference is due to a couple of factors. One is that the boundary of the ESRV is greater than the active SRV model boundary. Therefore, some of the data collected falls outside of the active SRV model boundary. The second factor is related to limitations of MODFLOW, the program used to construct the SRV model. If a model cell is dewatered, the pumping associated with that cell-layer is no longer included in the pumping applied to the model. This normally occurs around the edges of the model, or where the depth to bedrock is shallow. An attempt was made to include the pumping by manually moving the pumping in cells that went dry to the next layer down. If all three layers went dry, then that pumping was not included in the model. The recharge portion of the model works slightly differently: if a cell-layer goes dry, MODFLOW applies the recharge to the next layer. However if all three layers are dewatered, the recharge is not applied to the model.

## Scenario 1 – Current / Base Case

The intent of the Base Case scenario was to capture the independent current long-term plans that water providers in the ESRV have concerning groundwater use out to the year 2030. This scenario also took into account regional impacts to the aquifer over time, such as the urbanization of agricultural land and projected recharge from Underground Storage Facilities (USF). Figure 4 shows the water levels in the ESRV for the year 2002. Except for a few notable exceptions, the projected water levels for the year 2030 showed the same general trend when compared to the 2002 water levels (Figure 5). Figure 6 shows the water level changed from the year 2002 to the projected water levels in 2030. Most of the ESRV showed only a slight increase or decrease (plus or minus 50 feet) in water levels from the year 2002. The areas of decline, for the most part, were limited to the southwestern and northern portions of the study area. In general, the areas of rise included the central, north central, and southeastern portions of the study area. The area that declines the most is a cone of depression in the Apache Junction area (North Meridian Road depression) that declines over 100 feet from 2002 to 2030. The depth to water in the year 2030 showed two major cones of depression; the North Meridian Road cone of depression, over 600 feet below land surface (bls), and the North Scottsdale cone of depression, over 1,000 feet bls (Figure 7). The large rises in water level showed a direct relationship to USF projects as can be seen on the DTW map (Figure 7). The larger USFs demonstrated the following rises from 2002 to 2030; GRUSP over 100 feet, Gilbert South USF over 150 feet, and the proposed Superstition Mountain USF with over 400 feet. The model simulation shows the water level rising to land surface at the GRUSP USF and the Superstition Mountain USF.

It was decided by the Forum to run the scenario out to the year 2100, keeping the 2030 conditions constant except with the addition of 10,000 acre-feet per year of pumping in the Maricopa East WPA (WPA 33). By the year 2100, the water levels demonstrated a greater variability than when the model was run out to 2030 (Figure 8). In general, the water level changes from the years 2002 to 2100 showed water level declines of 100 to 200 feet over most of the ESRV (Figure 9). The North Meridian Road depression declined 300 feet from the year 2002 to a depth to water of 800 feet bls (Figure 10). In addition, a new cone of depression developed in the Queen Creek Wash area declining 100 feet from the year 2002 and over 300 feet from the year 2030. The northern Scottsdale cone expanded and declined another 100 feet. The few rises in the water levels could be directly related to USFs. The rises from the USFs were less or unchanged compared with the results from the year 2030. Figure 11 and Figure 12 show a color representation of the water level change from 2002 to 2030 and 2100, respectively.

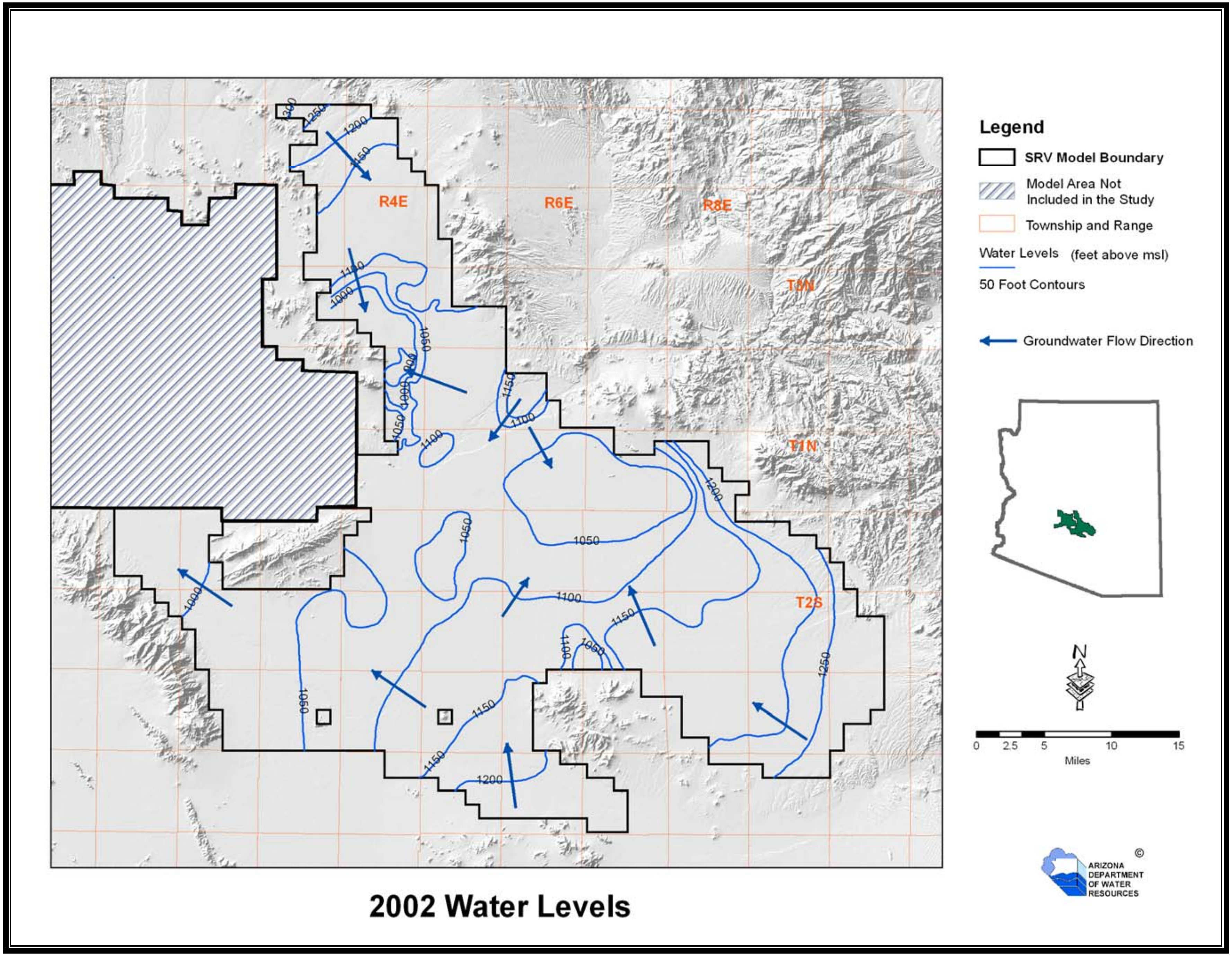


Figure 4. Water Level Map for the Year 2002.

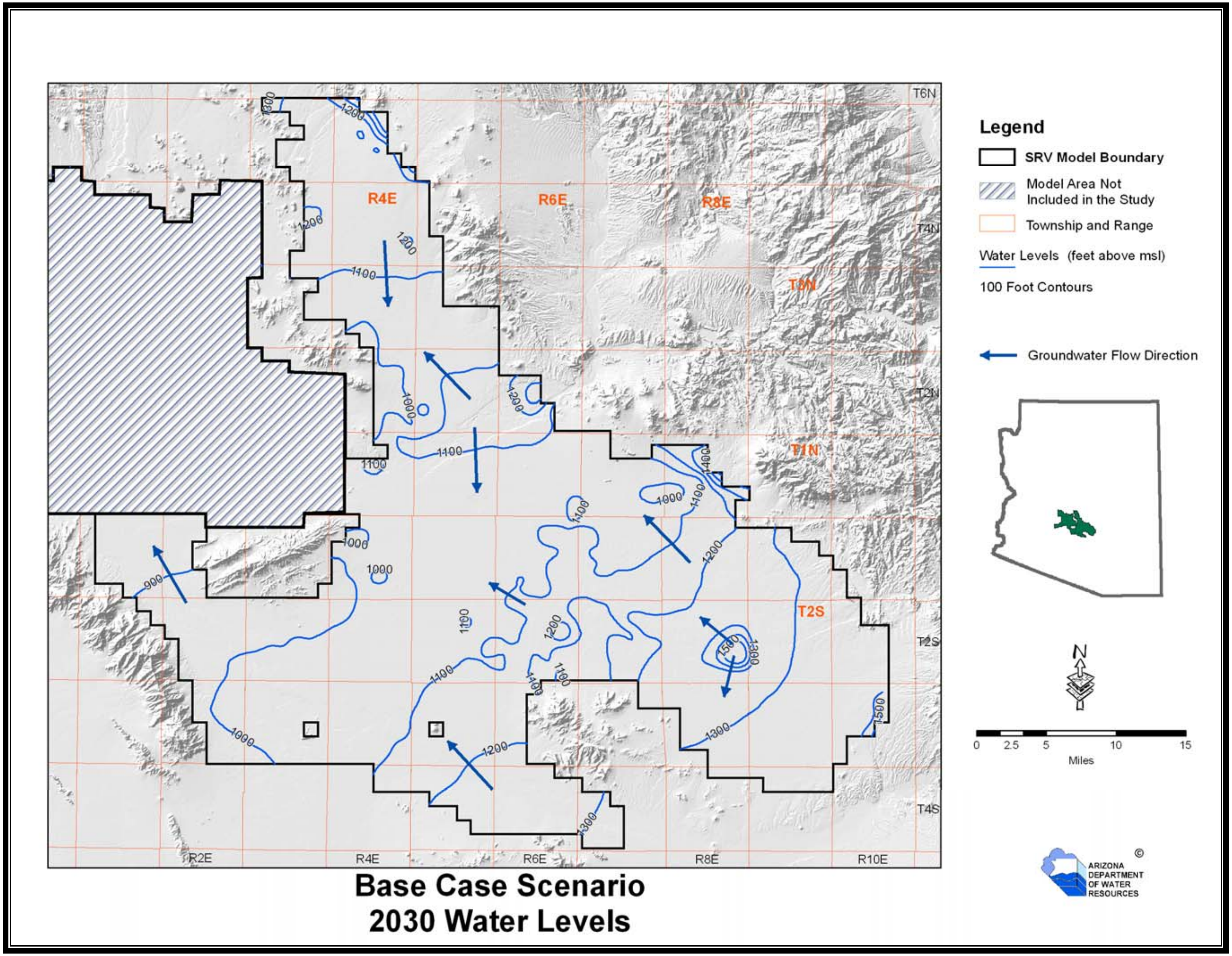


**Figure 5. Base Case Scenario Water Level map for the year 2030.**

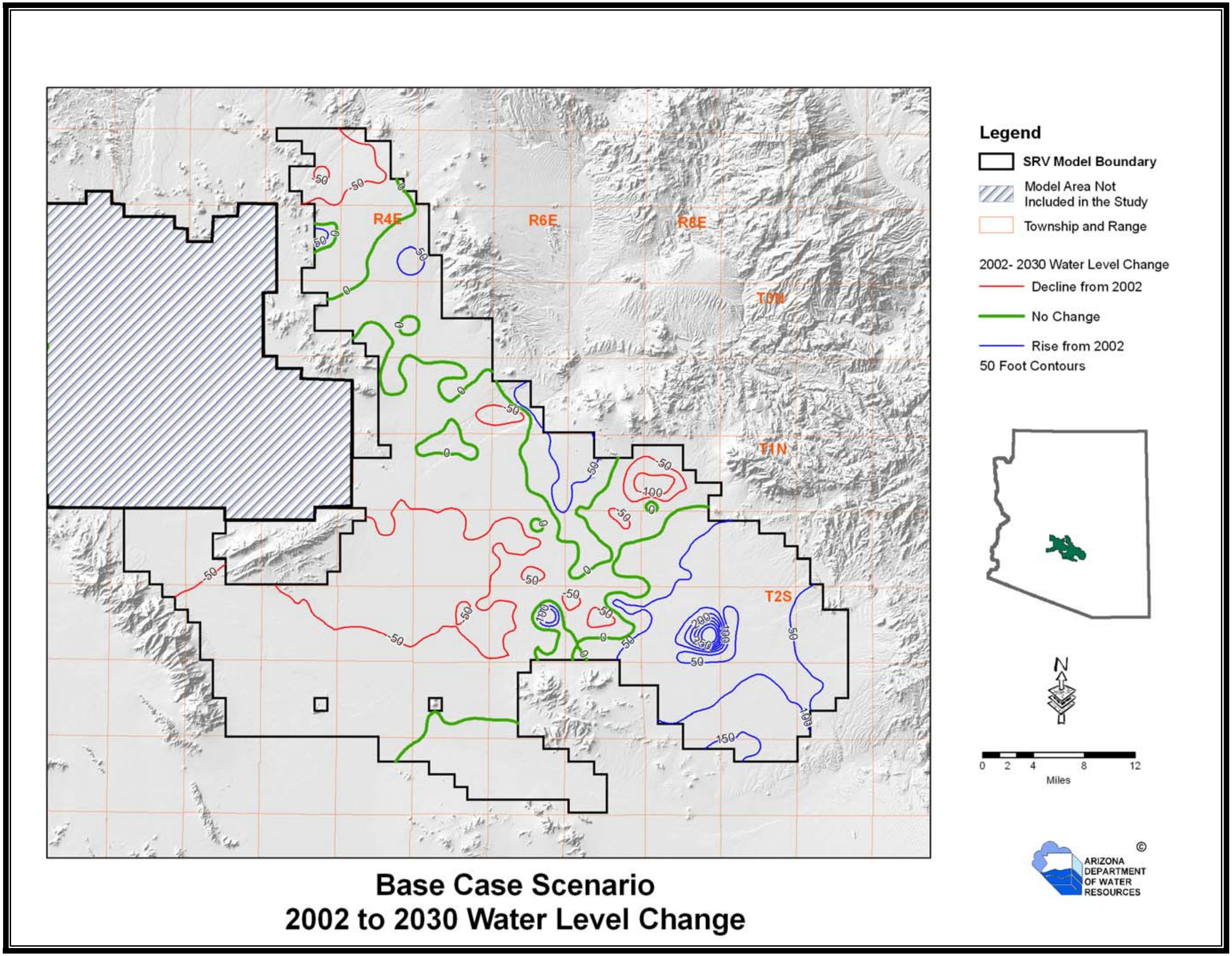


Figure 6. Base Case Scenario Water Level Change map from 2002 to 2030.

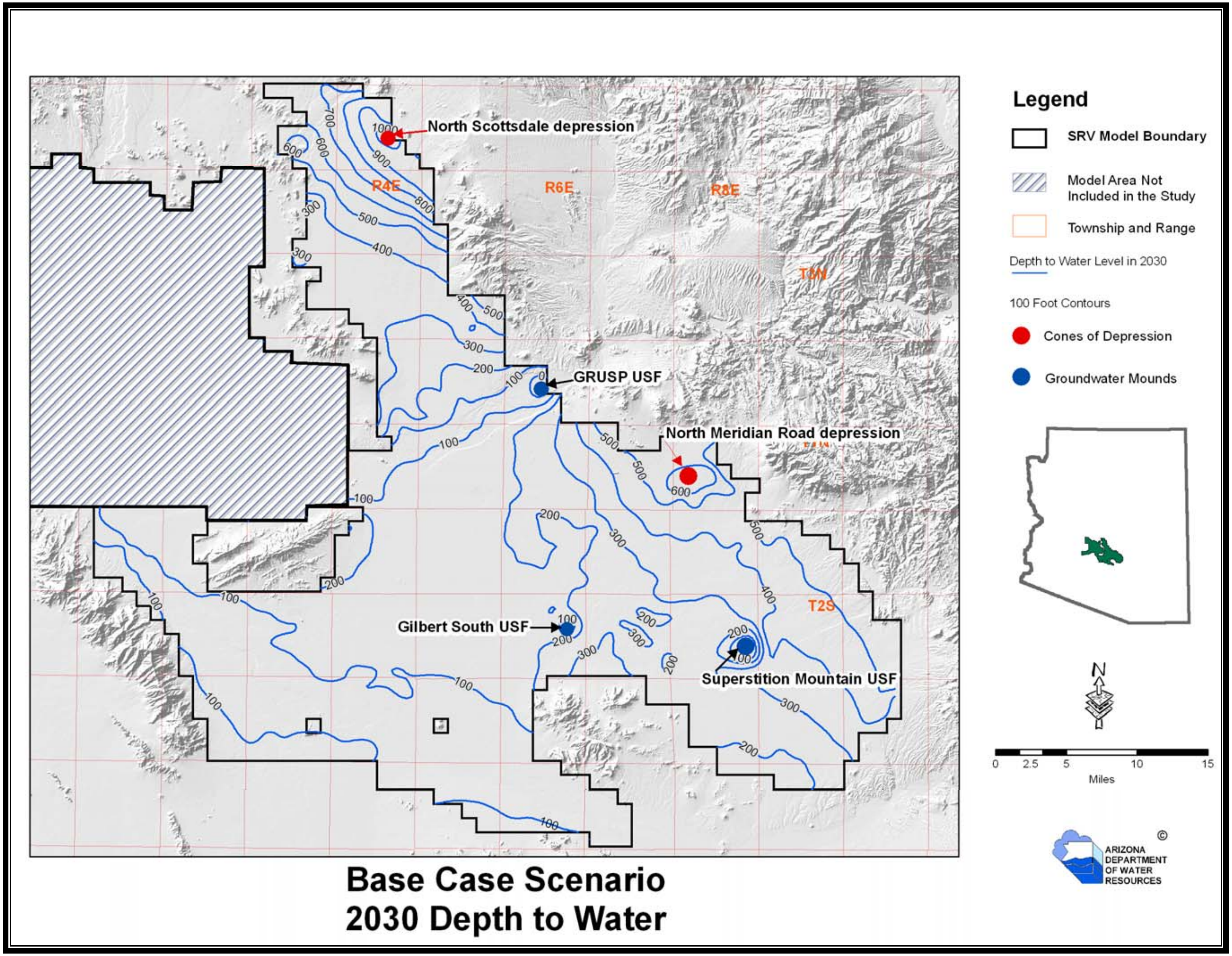


**Figure 7. Base Case Scenario Depth to Water for the year 2030.**

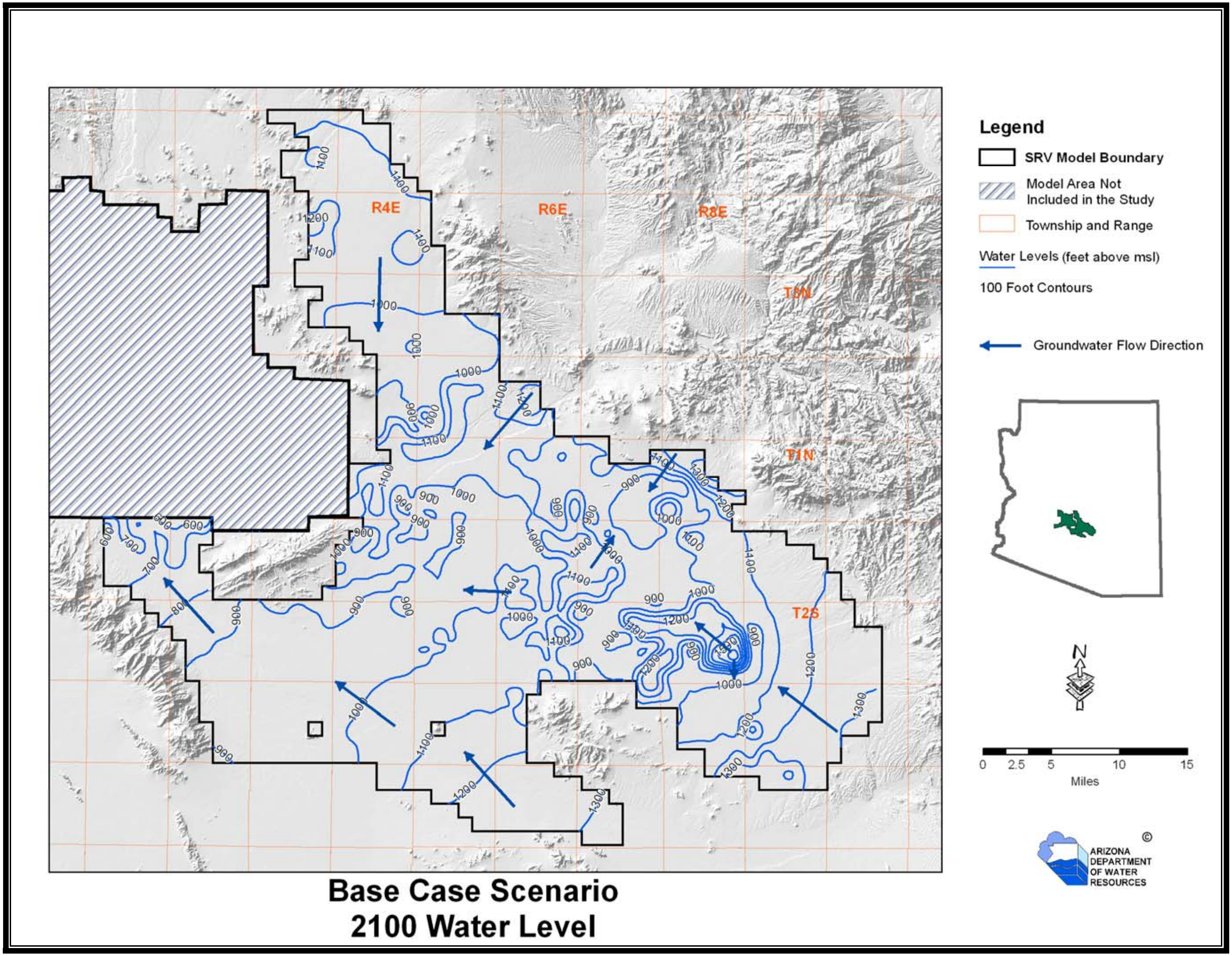


**Figure 8. Base Case Scenario Water Level map for the year 2100.**

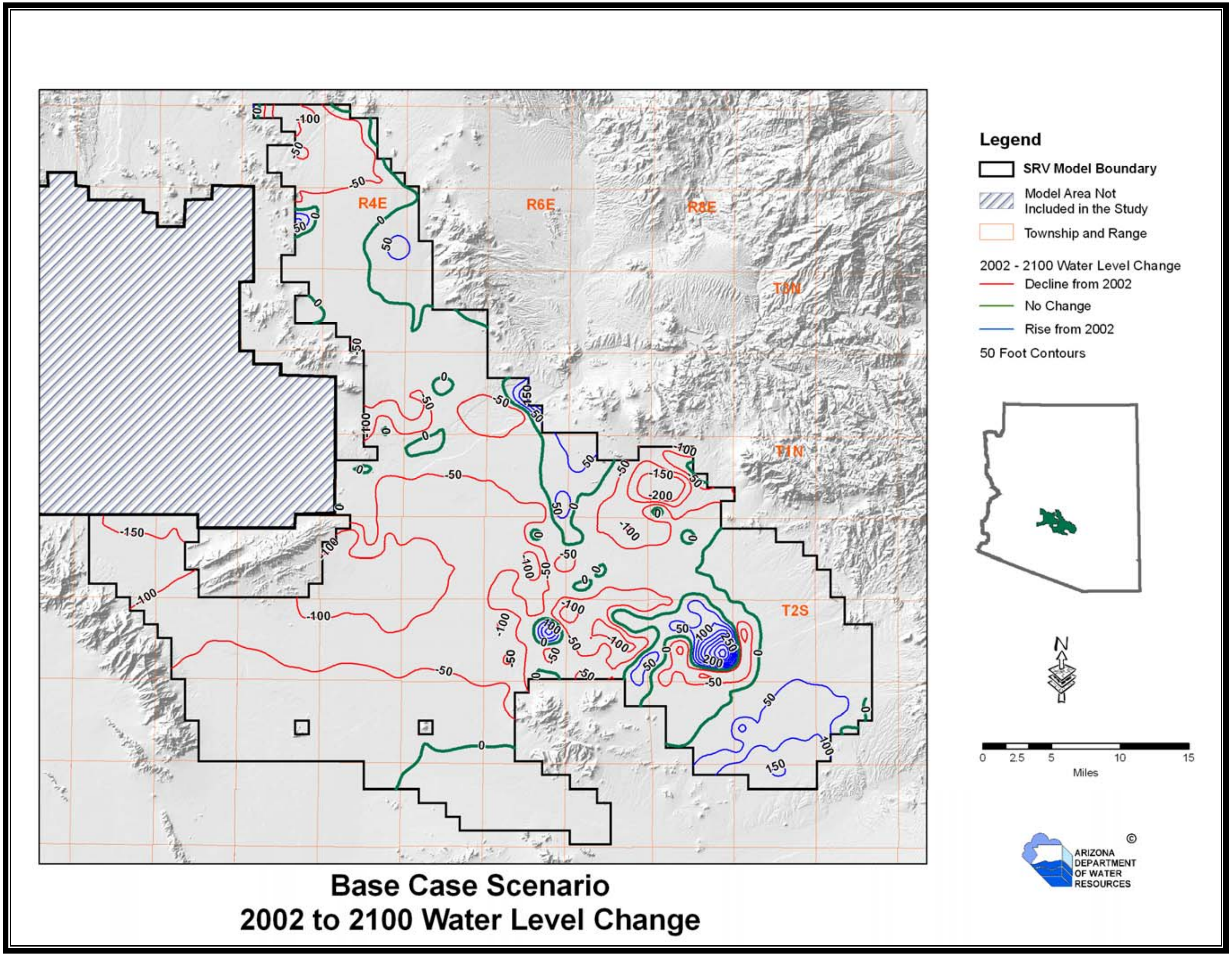


**Figure 9. Base Case Scenario Water Level Change map from 2002 to 2100.**

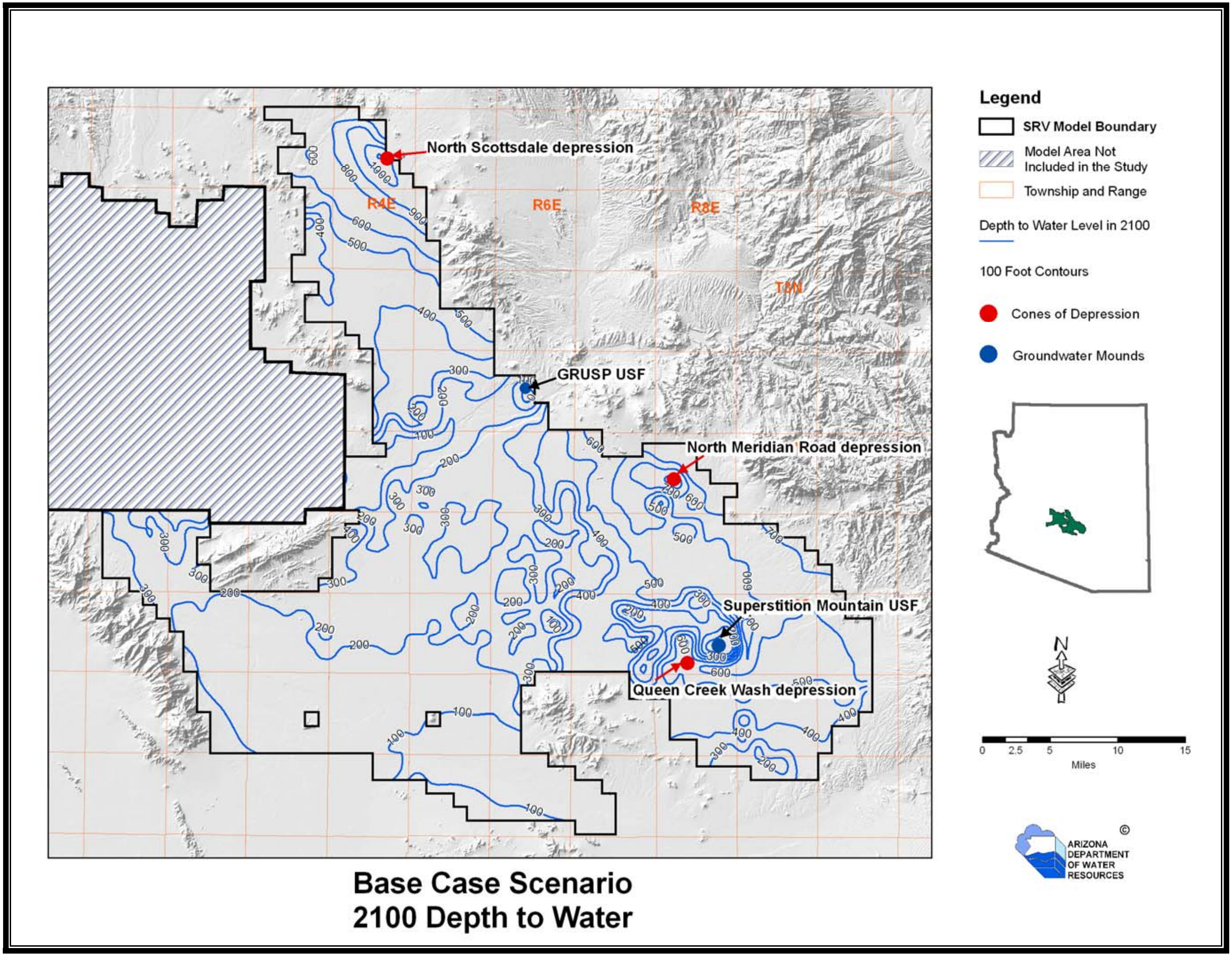


Figure 10. Base Case Scenario Depth to Water map for the year 2100.

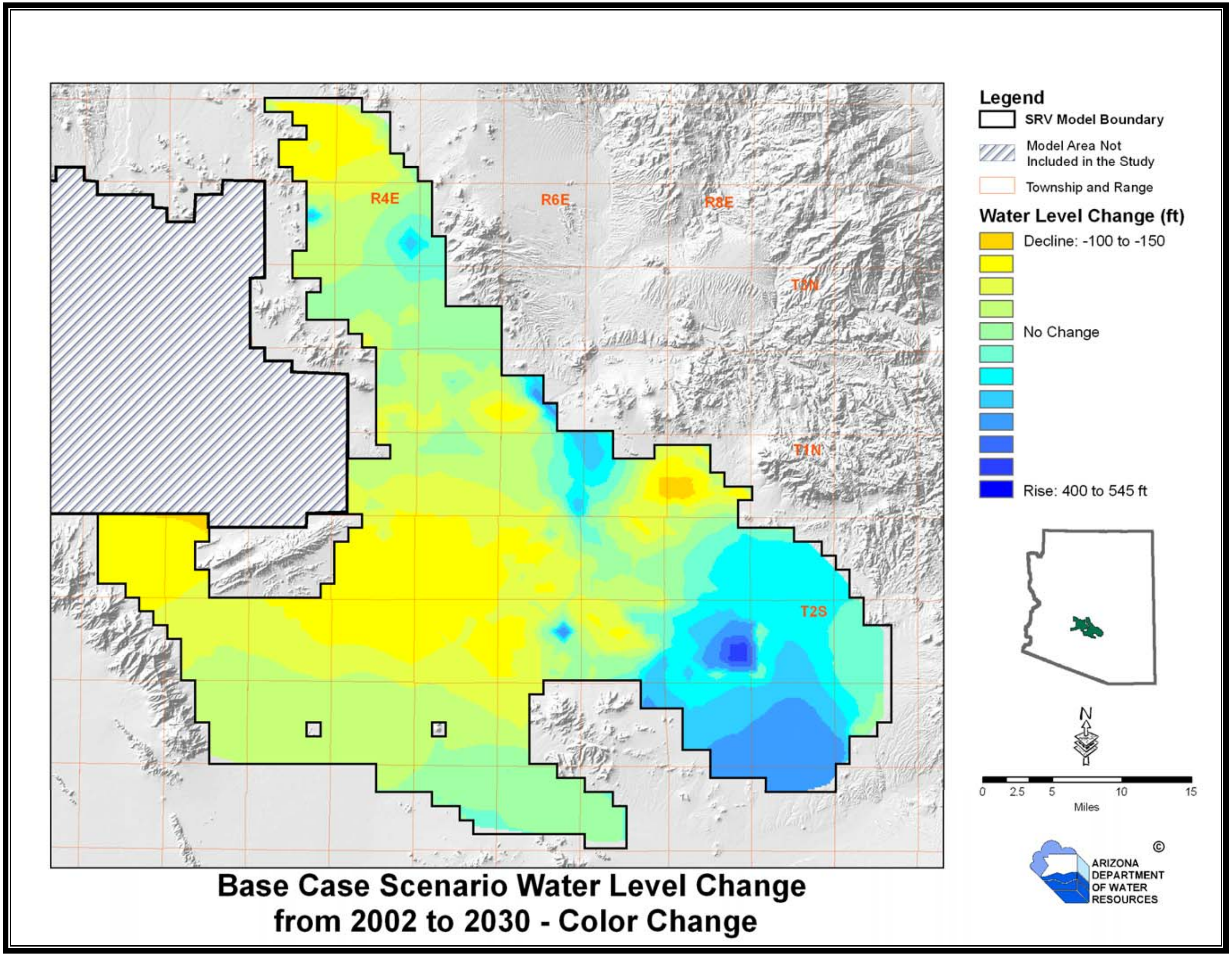


**Figure 11. Base Case Scenario Water Level Change from 2002 to 2030 – represented by change in color.**

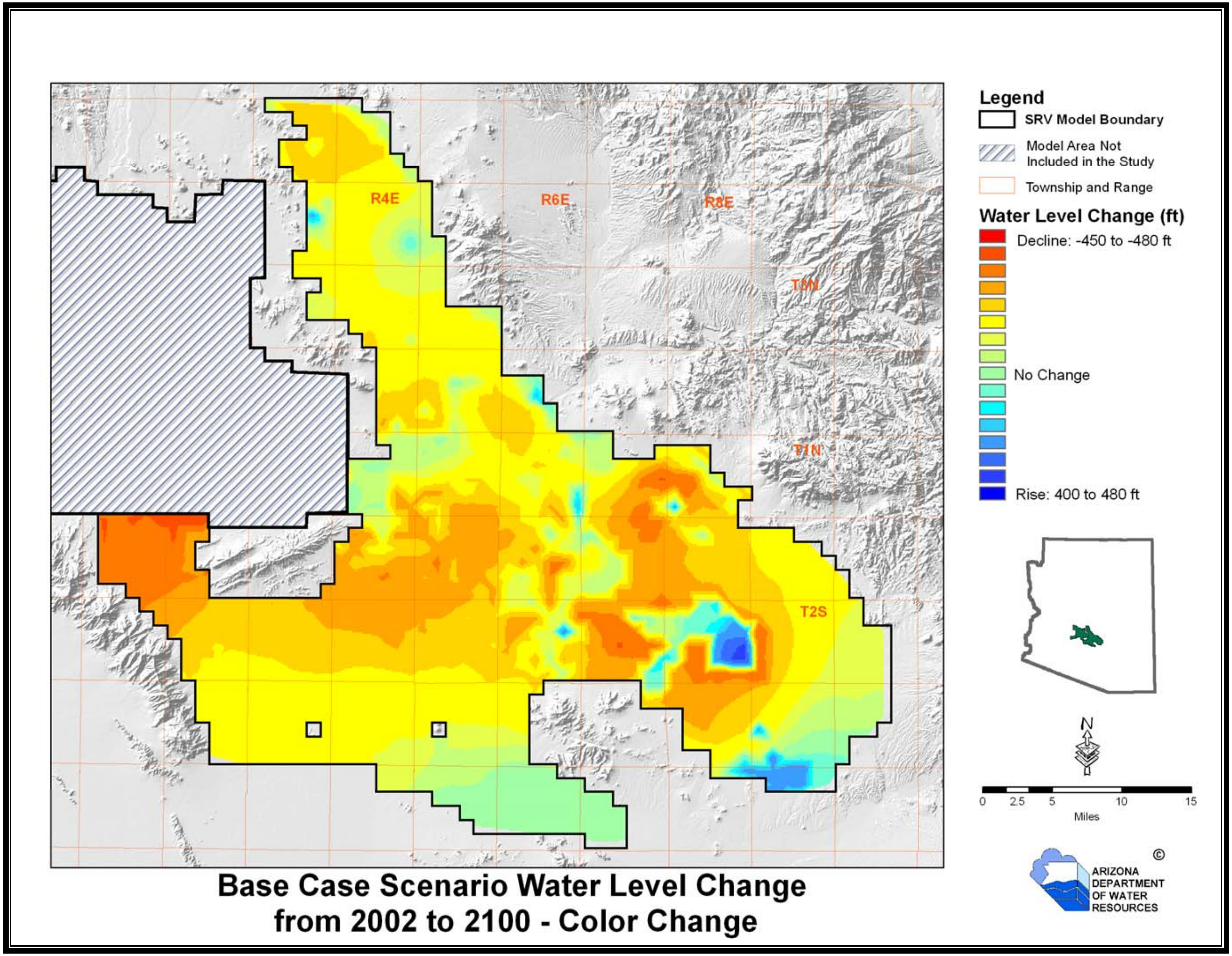


**Figure 12. Base Case Scenario Water Level Change from 2002 to 2100 - represented by change in color.**

**Scenario 2 – Balanced Pumping and Recharge**

Scenario 2 was designed to represent a relative balance between the annual amount of groundwater withdrawn and the annual amount of natural and artificial recharge in the ESRV sub-basin. The Forum decided to use the 2020 pumpage and recharge rates from the Base Case Scenario because they were the closest to representing "safe yield" conditions in the ESRV. The 2020 rates were held constant out to the year 2100. The difference between the projected recharge and pumping data in the ESRV for the year 2020 was +14,041 acre-feet per year (Table 12). Within the SRV model boundary, the 2020 projected difference between recharge and pumping was -7,876 acre-feet per year (Table 15). This scenario allowed the Forum to:

- Identify how much groundwater development might take place sustainably given a balance between recharge and pumping.

- Identify the sub-regional or localized aquifer problems that might continue or develop even with an overall balance between groundwater withdrawals and recharge.

- Identify where and when additional infrastructure (distribution lines, recharge facilities, etc.) may need to be developed to facilitate a balance between groundwater withdrawals and recharge.

As expected, there was very little difference by the year 2030 from the Base Case Scenario. The Scenario 2 water level map for the year 2100 (Figure 13) showed less variability than the Base Case Scenario (Figure 8). The water level change from 2002 to 2100 showed declines in the western half of the ESRV ranging from 50 feet to 100 feet (Figure 14). The eastern half of the ESRV was dominated by the Superstition Mountains USF, showing water levels rising over 250 feet from 2002. The North Meridian Road depression continued to expand, with water levels declining another 100 feet from the year 2002 (dtw of 600 feet, Figure 15). The North Scottsdale cone of depression was still present, however, it was slightly less pronounced under this scenario compared to the Base Case Scenario. Even though this scenario represented "safe yield", there was still an overall decline in the western half of the ESRV. This is not a surprise considering that over 90,000 acre-feet per year of recharge from the GRUSP and Superstition Mountains USF is located on the eastern side of the ESRV basin. As with the Base Case Scenario, the model simulation shows the water level rising to land surface at the GRUSP USF and the Superstition Mountain USF. With less pumping in Scenario 2, the water level above land surface was not as large as that indicated in the Base Case Scenario.

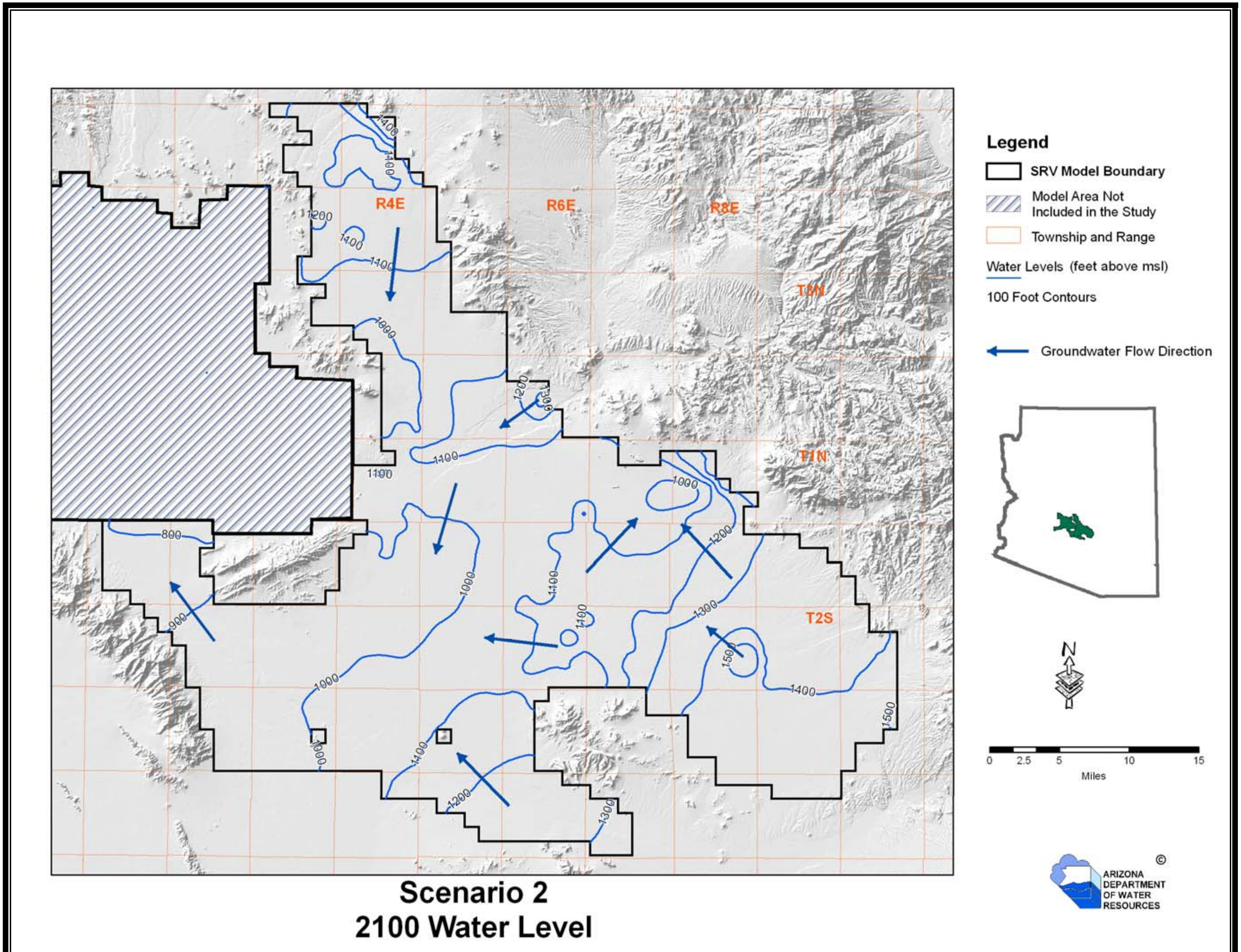


**Figure 13. Scenario 2 Water Level Map for the year 2100.**

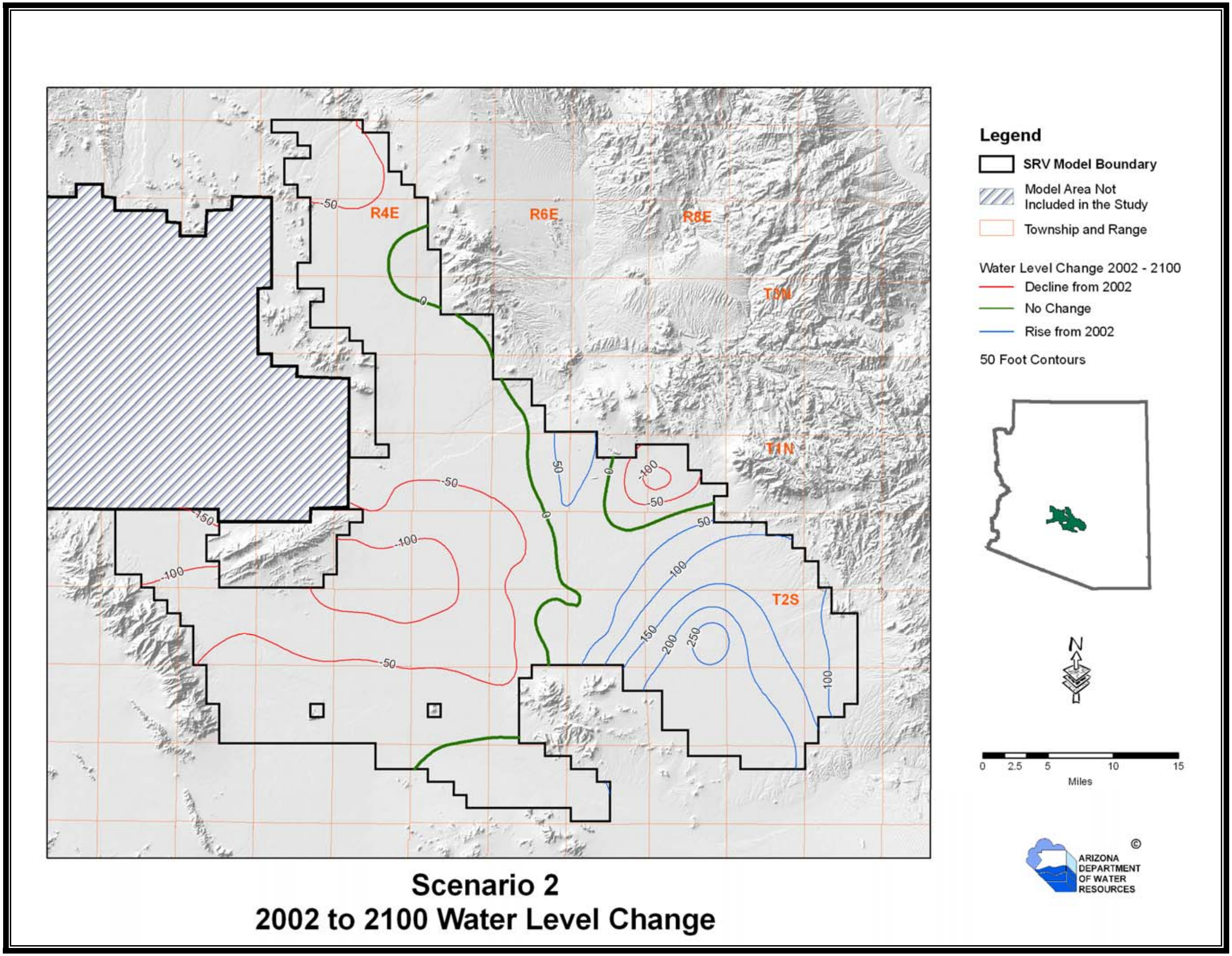


**Figure 14. Scenario 2 Water Level Change Map from the year 2002 to 2100.**

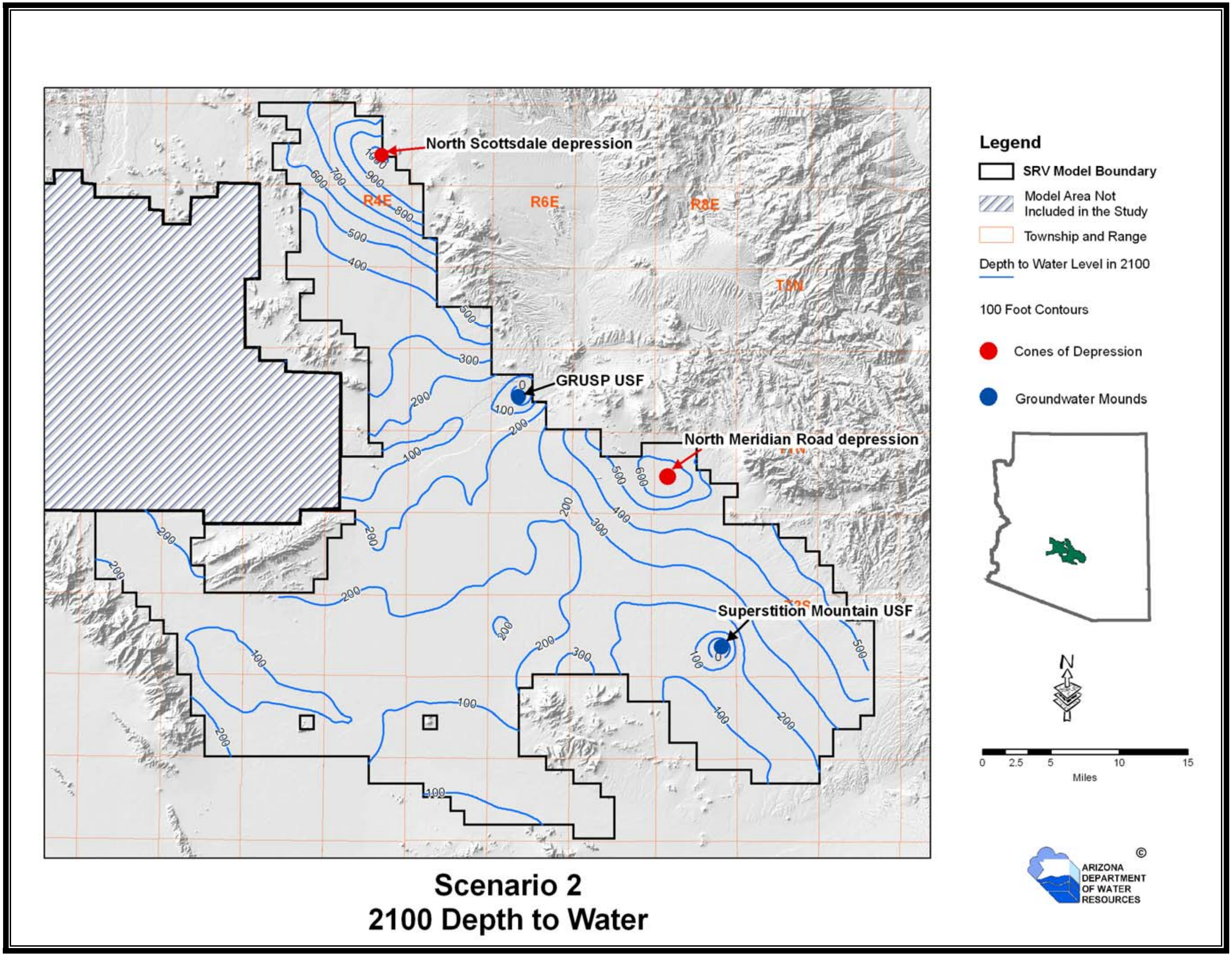


**Figure 15. Scenario 2 Depth to Water Map for the year 2100.**

## Scenario 3 – Ideal Management

With the knowledge gained from running the Base Case and Scenario 2, Forum members developed a series of scenarios that looked at ways of possibly reducing the cones of depression that form in the Base Case Scenario. This scenario focused on the two main cones of depression: the North Meridian Road depression and the Queen Creek Wash depression. The different versions of Scenario 3 used the same assumptions as the Base Case Scenario except for the differences outlined below.

### Scenario 3A:

To reduce the Queen Creek Wash cone of depression, the Forum chose to reduce the amount of municipal pumping associated with the Maricopa East WPA (WPA 33) to equal the amount of recharge at the Superstition Mountain USF for the period from 2025 to 2100 (56,500 af/yr).

To reduce the North Meridian Road depression, the Forum decided to move the majority of the municipal pumping in the vicinity of the cone further south, closer to the Superstition Mountain USF. The municipal pumping for Apache Junction (WPA 1) and Arizona Water Company (WPA 2) was reduced by 75% in the area of the depression for the 2020 stress period and beyond (Table 16). The volume of pumping that was reduced from the two WPAs was moved to the southern extent of WPA 1 and the southwestern limit of WPA 2. Figure 16 shows the original distribution of municipal pumping for the two WPAs and the additional pumping areas for Scenario 3A.

**Table 16. Pumping Volume Reduced from the North Meridian Road Cone of Depression**
(acre-feet/year)

| WPA | 2020 | 2025 | 2030 |
|---|---|---|---|
| Apache Junction WPA 1 | 2,738 | 3,825 | 5,625 |
| Arizona Water Company WPA 2 | 6,531 | 7,390 | 8,399 |
| **Total** | **6,531** | **11,215** | **14,024** |

The reduction in pumping in the area of the cones lessened the impact compared to the Base Case Scenario in the year 2100 (Figure 17). The depth to water at the Queen Creek Wash depression went from 600 to 700 feet bls in the Base Case Scenario to 300 to 500 feet bls in this scenario (Figure 18). Moving the pumping at the North Meridian Road depression did not have as much of an impact. In the Base Case Scenario for the year 2100, the DTW was 800 feet bls. Scenario 3A reduced the DTW to 700 feet bls for the same time period.

With the decreased recharge at the Superstition Mountain USF the water level did not reach land surface. However, the water level still reached land surface at the GRUSP USF.

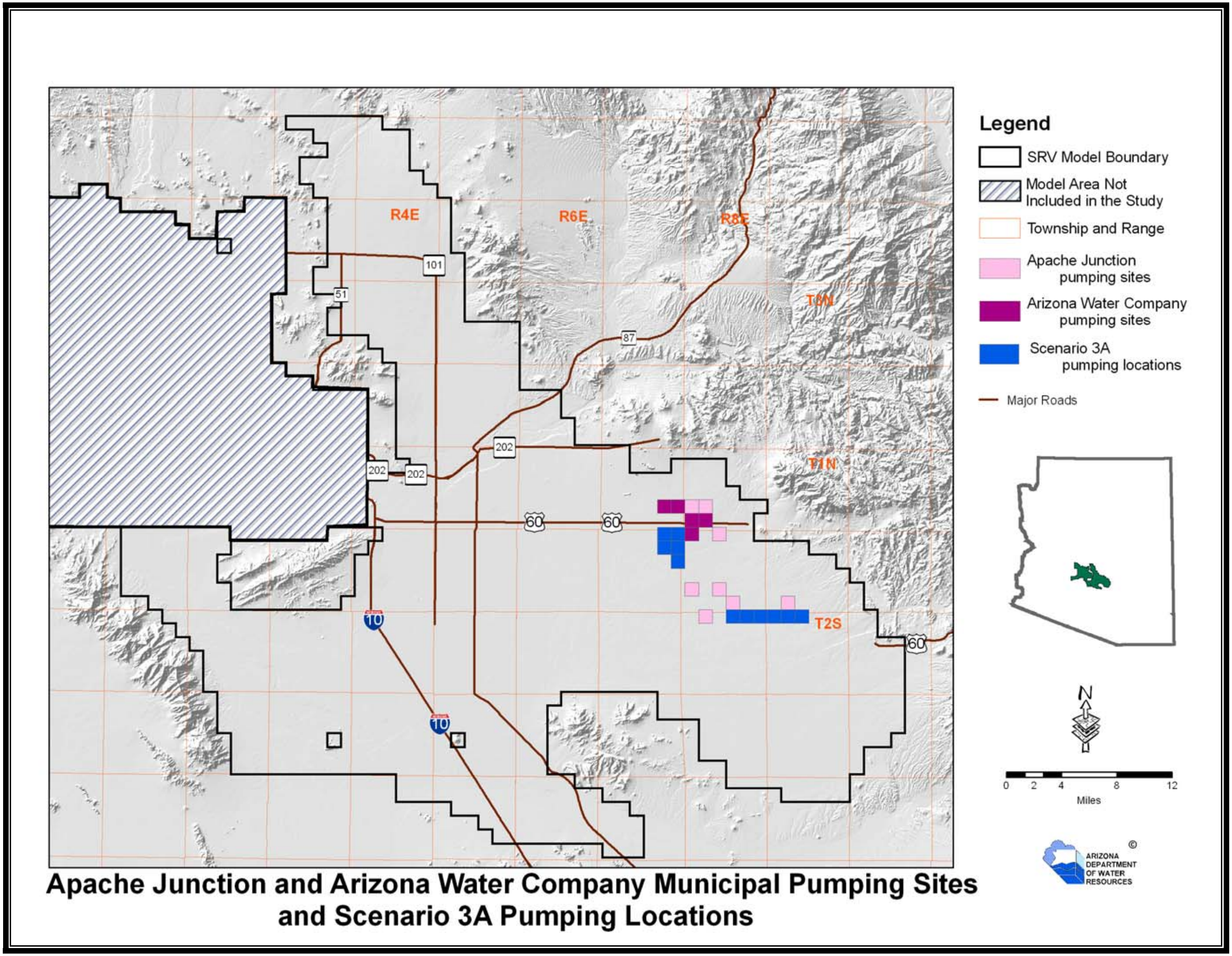


**Figure 16. Apache Junction and Arizona Water Company Municipal Pumping Sites and Scenario 3A Pumping Locations.**

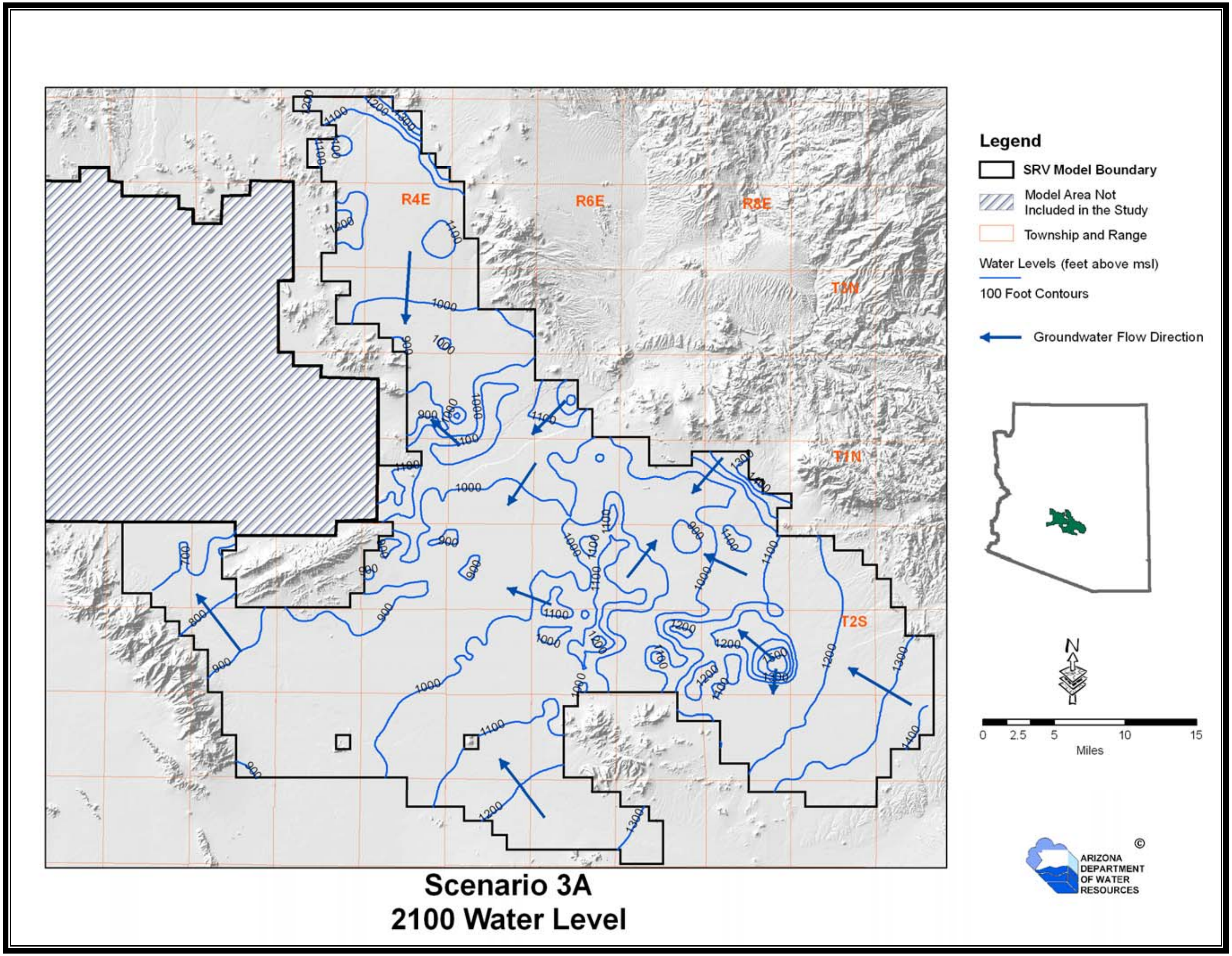


**Figure 17. Scenario 3A Water Level Map for the year 2100.**

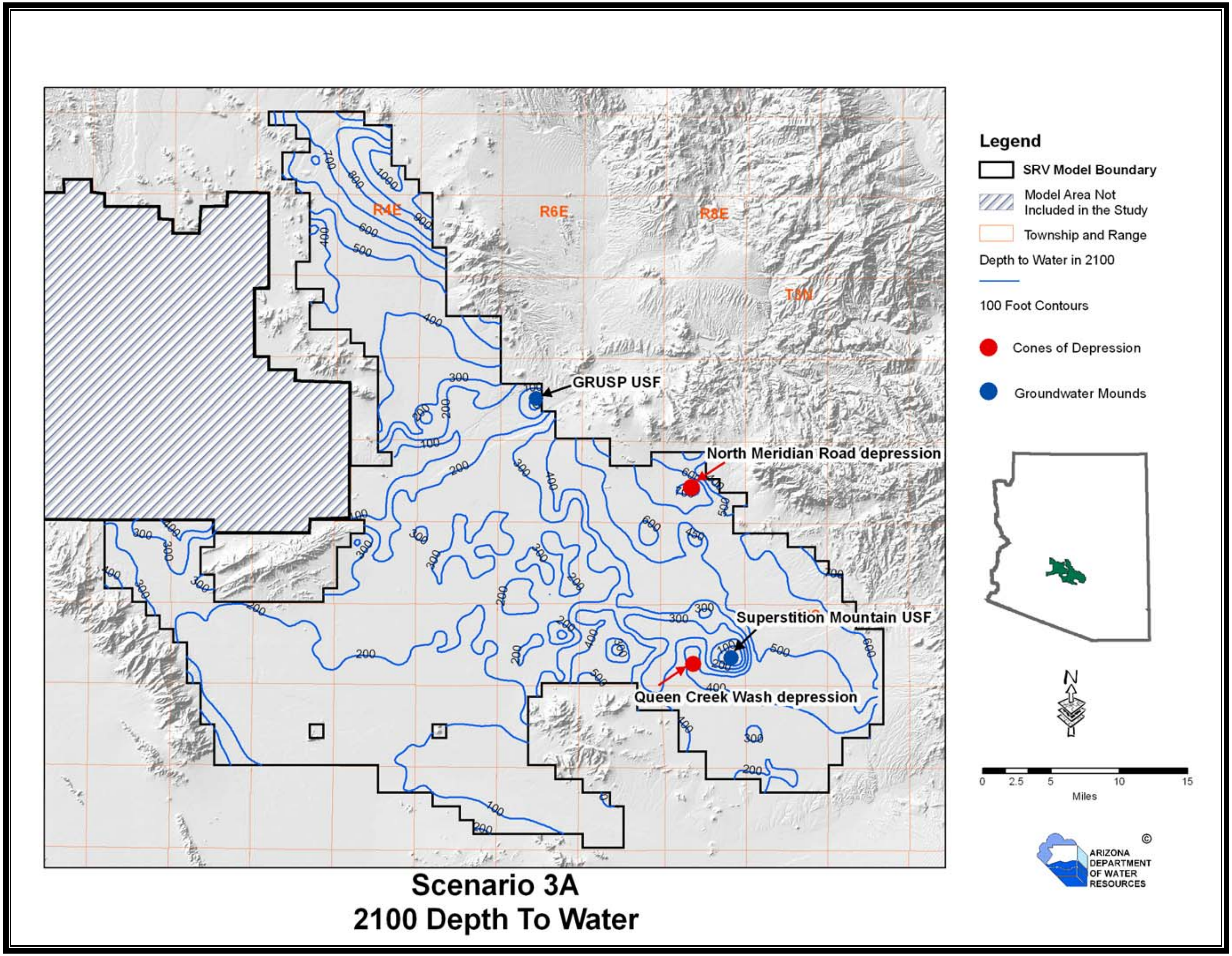


**Figure 18. Scenario 3A Depth to Water Map for the year 2100.**

**Scenario 3B:**

This scenario looked at moving the reduced pumping from the Apache Junction WPA (WPA 1) and the Arizona Water Company WPA (WPA 2) to the northeast (Figure 19). All other assumptions used in Scenario 3A were kept constant. The groundwater mound created by the GRUSP USF was reduced compared to Scenario 3A (Figure 20), however, the water level still reached land surface (Figure 21). Depth to water at the North Meridian Road depression was reduced another 50 feet compared to Scenario 3A by the year 2100 (DTW of 650 feet vs. a DTW of 700 feet for Scenario 3A) (Figure 21).

**Scenario 3C:**

This last scenario used the same assumptions as Scenario 3A and also reduced the pumping for Superstition Vistas, in WPA 33, by an amount equal to the volume of pumping moved from the Apache Junction area. Figure 22 shows the pumping locations for Scenario 3A and the location of where the pumping was reduced for Scenario 3C. Further reducing the pumping in the Maricopa East WPA (WPA 33) generally reduced the impact of moving the pumping to the south seen in Scenario 3A (Figure 23). Reducing the pumping in the Maricopa East WPA (WPA 33) reduced the Queen Creek Wash depression to a DTW of approximately 350 feet bls by the year 2100. The North Meridian Road depression was reduced to a DTW of approximately 650 feet bls. Reducing the pumping in WPA 33 also reduced the impact that was caused by moving the municipal pumping (Scenario 3A) from the area of the North Meridian Road depression (Figure 24). The North Meridian Road depression was aerially reduced compared to Scenario 3A, however, the maximum DTW was still 700 feet bls.

Decreasing the pumping near the Superstition Mountain USF caused the water level to barely rise to land surface. The water level still reached land surface at the GRUSP USF.

## Comparison

Not surprisingly when the pumping is reduced, there is less projected water level decline. The Queen Creek Wash depression was reduced by as much as 300 feet when the projected municipal pumping for WPA 33 was reduced by 23,500 af/year. However, it was surprising that reducing the pumping in the North Meridian Road depression by 75% (14,024 af/year by the year 2030 to 2100) did not have a larger impact. The water level continued to drop even though it was at a slower rate (200 feet of water level decline for Scenario 3A compared to 300 feet of decline for the Base Case Scenario by the year 2100). The different scenarios show how the hydrogeologic conditions, the volume of projected recharge and pumping, and the location of the pumping can affect the water table. Scenario 3 also demonstrates that recharge projects can be an effective tool in assisting to manage regional water resources. The Forum was able to test different possible solutions, sometimes with surprising results. Reducing pumping in the area of the North Meridian Road depression did not have the expected impact. The model allowed the Forum to experiment with different solutions and plan more efficiently for the future.

# Summary and Conclusions

ADWR's involvement in the Forum was two fold; 1) as a participating member of the Forum and, 2) as the technical support to run the SRV groundwater model and assist with technical development of the scenarios. The intention of this report is to document the use of the groundwater flow model that was used and the scenarios that were run for the development a Forum regional water management plan for the East Salt River Valley. The Base Case Scenario provided a good format for looking at the current conditions and determining what could be expected if those conditions were carried out into the future. There were significant water level declines throughout the ESRV and the declines would have been more severe without the presence of large Underground Storage Facilities. Scenario 2 gave the Forum members an idea of what would happen if pumpage and recharge were in an approximate overall balance for the entire ESRV. Even with pumping and recharge approximately balanced, there were still portions of the ESRV that demonstrated water level declines. Scenario 2 showed the importance of balancing, regionally, the amount of pumping and recharge and also the importance of the distribution of pumping in relationship to recharge. Scenario 3 allowed the Forum to try different solutions to determine which ones would have the most favorable impact locally and regionally.

The scenarios were designed by the Forum as a group to answer specific questions. The data provided for the projections represent the Forum's view of potential future groundwater pumping and recharge conditions. The Forum's view does not necessarily represent ADWR's official view on any particular projected pumping or recharge volumes or associated assumptions. As with any regional groundwater model projection, the main value is found in comparing the scenarios with each other and not in attempting to precisely predict the water levels in the year 2100. These scenarios were completed specifically to provide information for the Forum's water management plan. Therefore, caution should be used if the results of these scenarios are used for other purposes besides those for which they were designed.

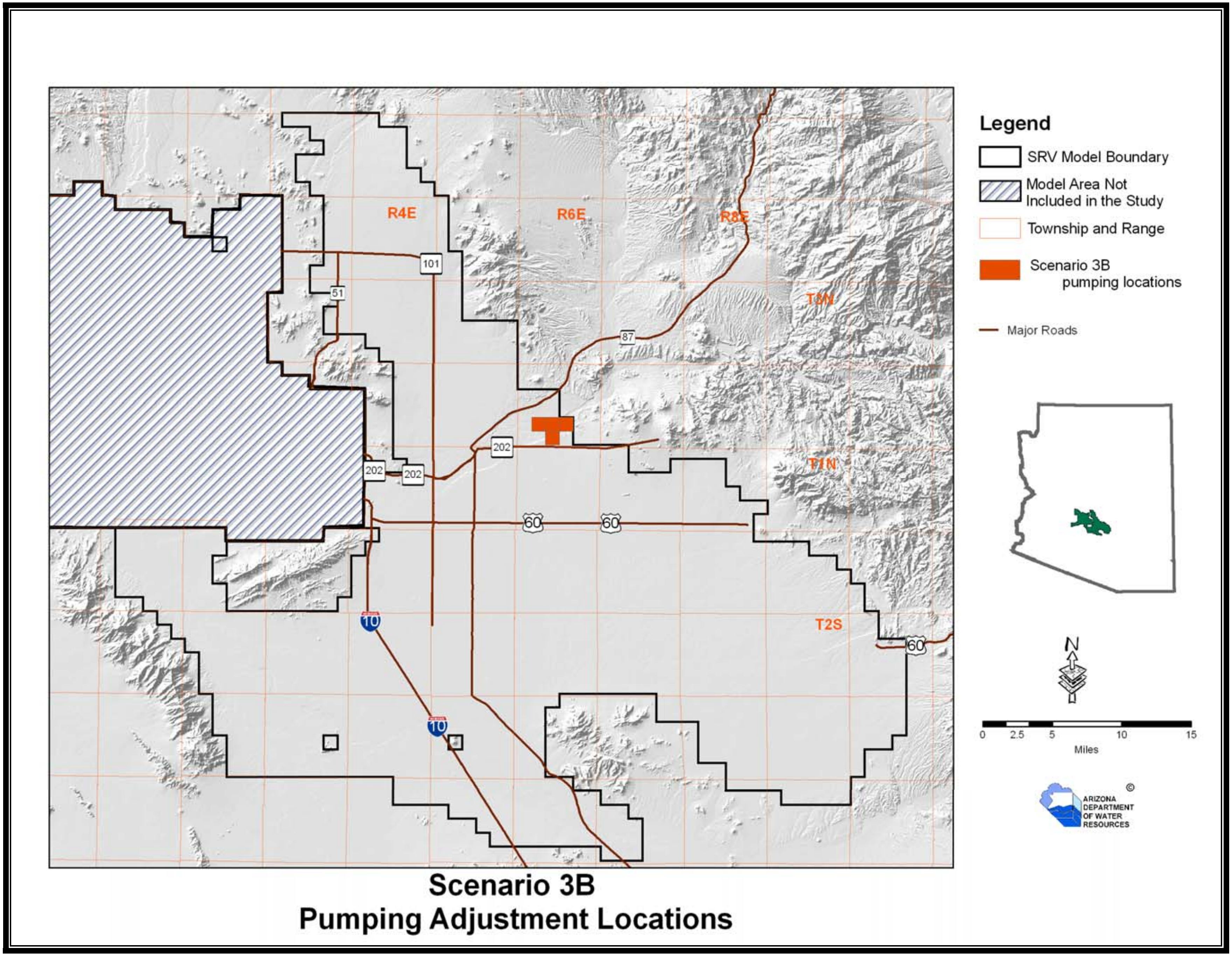


**Figure 19. Scenario 3B Pumping Locations.**

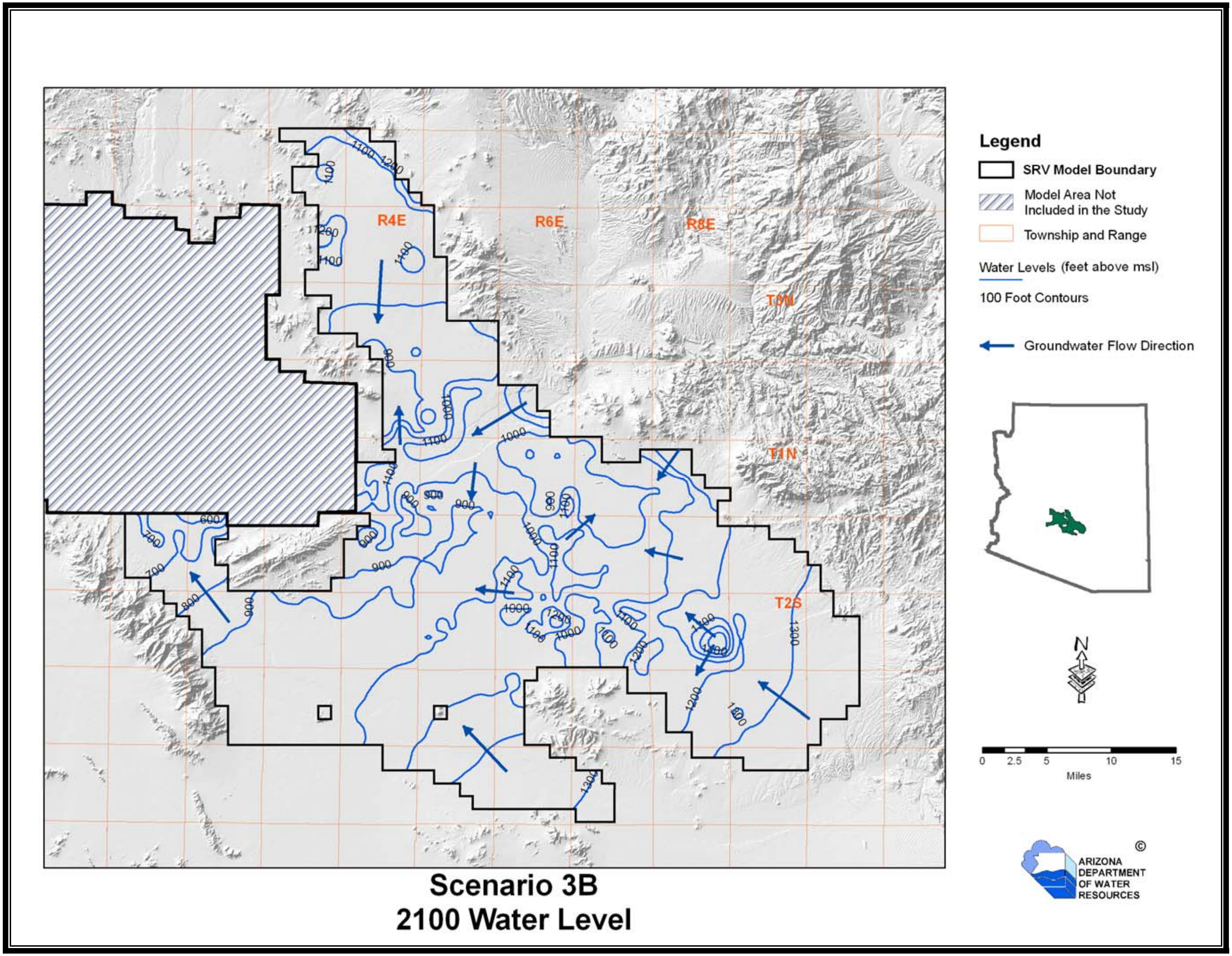


Figure 20. Scenario 3B Water Levels for the year 2100.

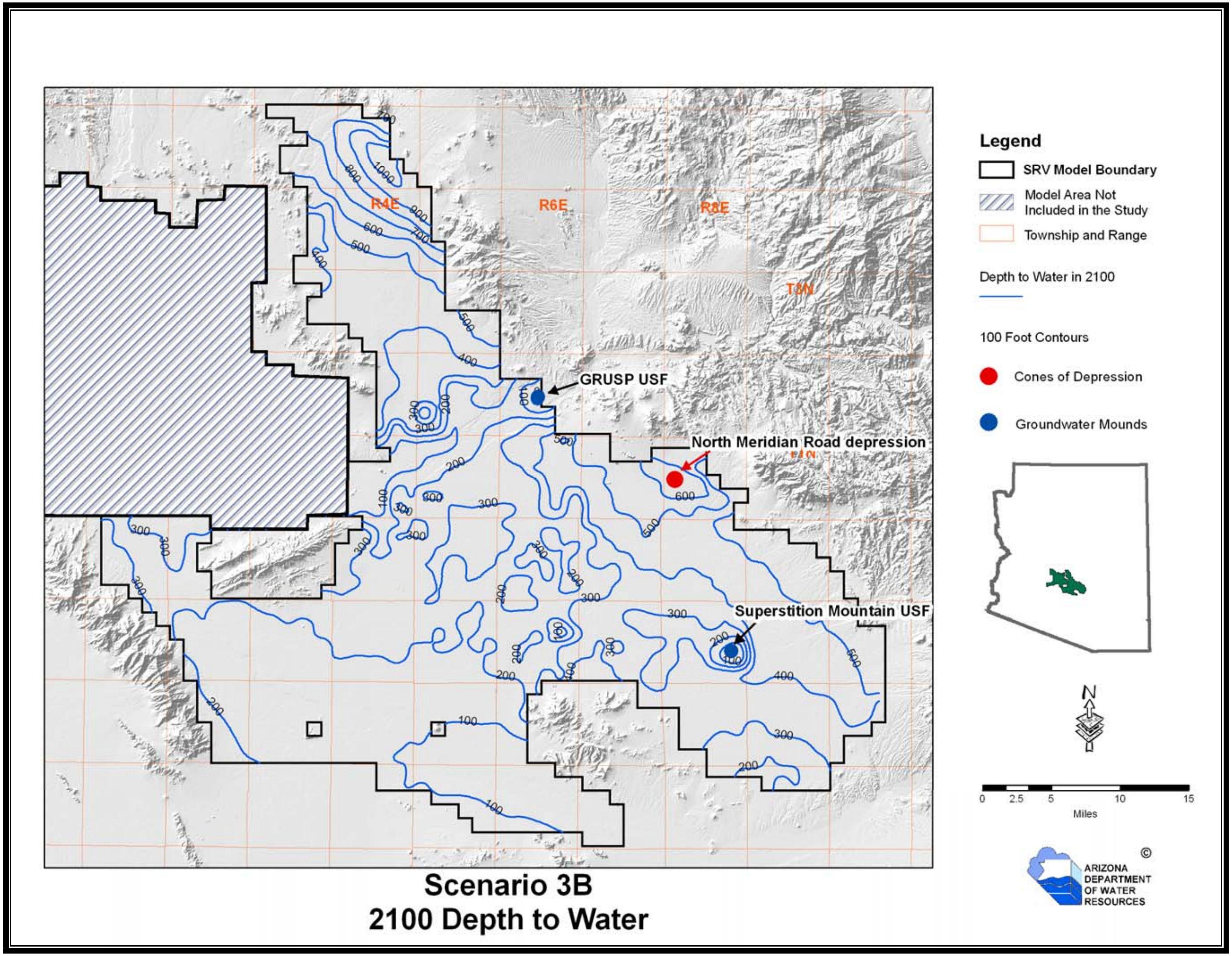


**Figure 21. Scenario 3B Depth to Water Map for the year 2100.**

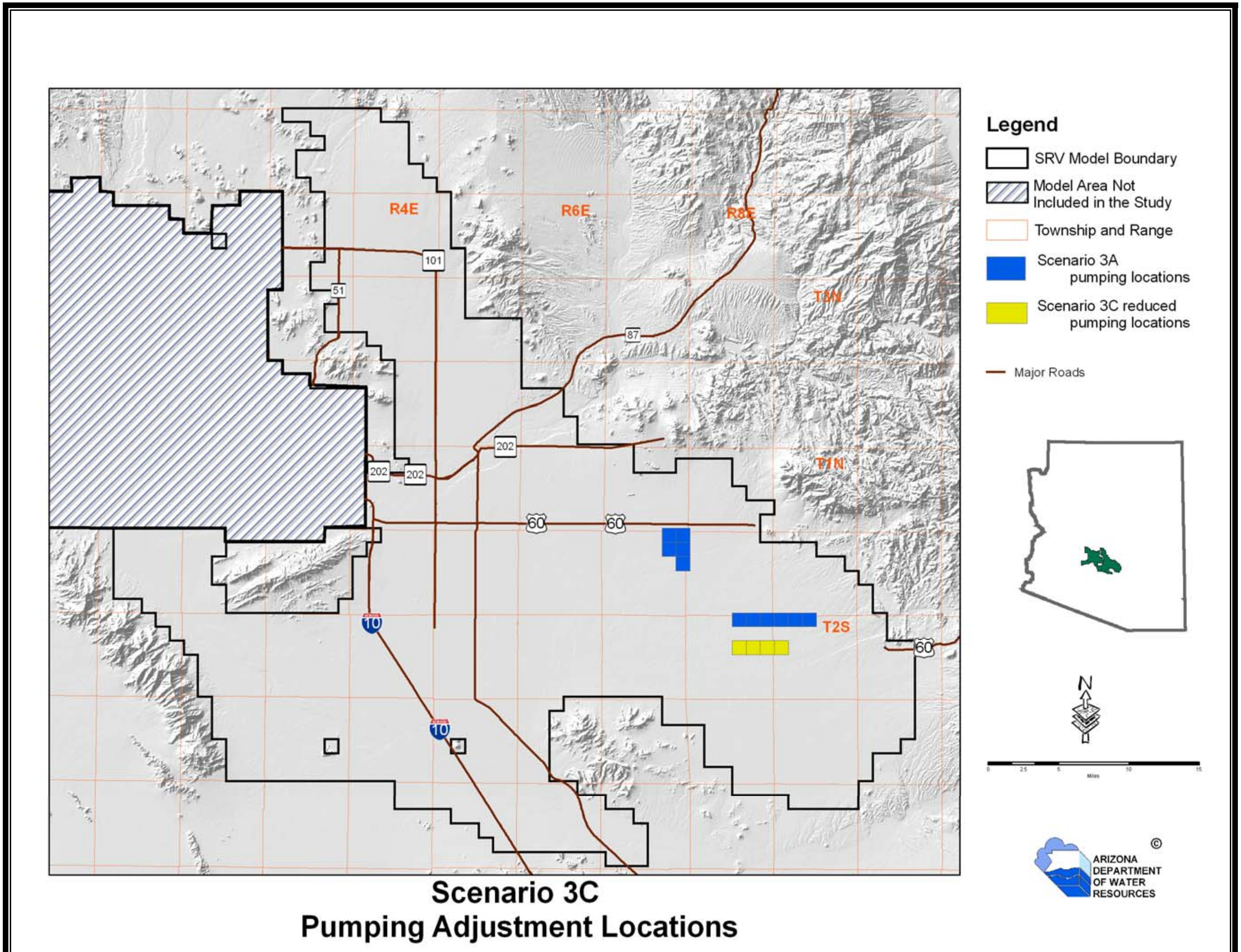


Figure 22. Scenario 3C Pumping Locations.

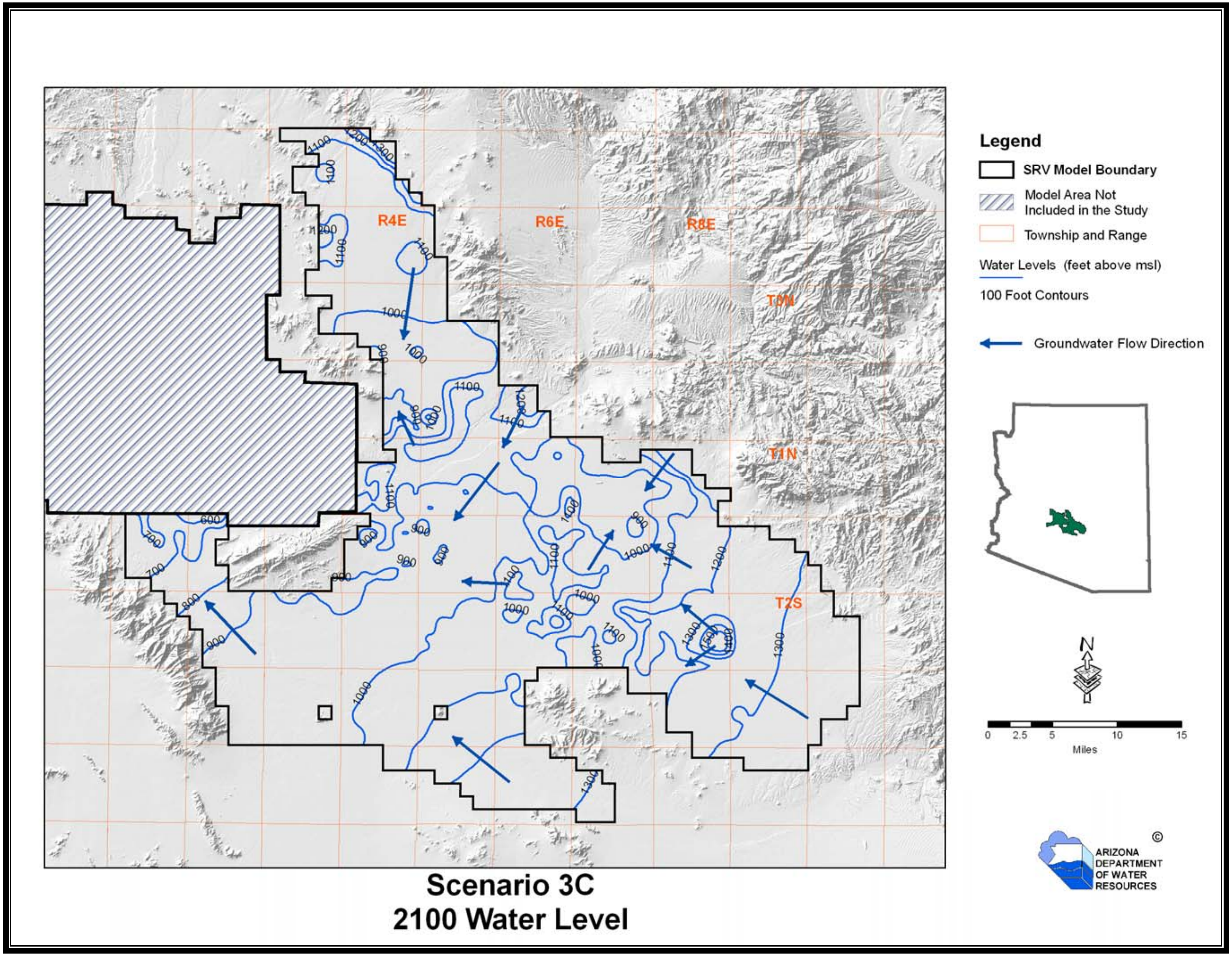


**Figure 23. Scenario 3C Water Level Map for the year 2100.**

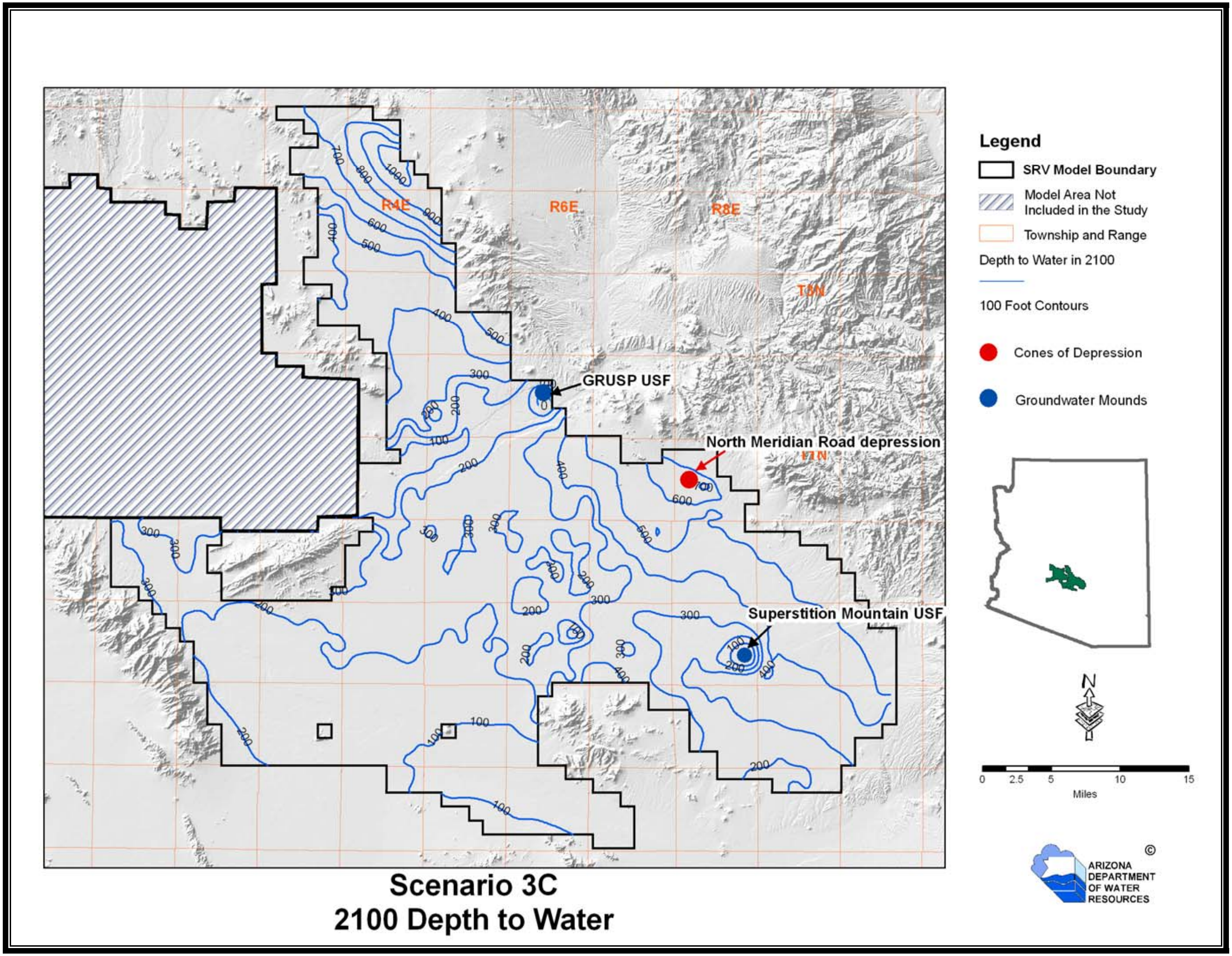


**Figure 24. Scenario 3C Depth to Water Map for the year 2100.**

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